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FOOD OF THE STRIPED BASS

By LEO SHAPOVALOV

The striped bass is a fish that holds a place of high esteem and popularity with California sportsmen, an esteem which, if anything, is constantly increasing. Quite naturally, knowledge concerning its life history and habits are and should be of great value, in that only with such knowledge can the conservation of any game fish and other fishes which it affects be effectively carried on.

We already know a good deal about the life history of the striped bass in California, especially about its age and growth, and these facts have been gathered together most completely by E. C. Scofield in Fish

Bulletin No. 29, published in 1931 (see Bibliography). However, the greatest gaps in our records concerning the life history and habits of this species exist in our knowledge of its migrations, exact spawning places and habits, and its food. As a matter of fact, the indications are that there is a close relationship between these three phases of its life history. The State Division of Fish and Game is beginning an investigation to fill in these gaps, but since it may be some time before these studies are completed, it seems advisable at this time to present some recent findings concerning the food of the striped bass, as well as to sum up past investigations made in this direction.

Scofield (*loc. cit.*) made observations on the feeding habits and food of the striped bass in San Francisco, San Pablo, and Suisun bays and adjacent sloughs, but examined the stomachs of only one series of fish to the north or south of the Golden Gate. "On this occasion the fish were in the mouth of the Salinas River and just outside in the breakers. The entire school was feeding on Velella (Portuguese man-of-war)."

Food of Striped Bass in Waddell Creek Lagoon

Because of the lack of observations on localities outside of the above-mentioned ones the examinations of the stomachs of a series of 47 bass taken in Waddell Creek, Santa Cruz County, in the spring of 1935 by A. C. Taft and the writer are of interest. These examinations are of double interest because both young silver salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo irideus*) were found in some of the stomachs. Although this is the first recorded case of either of these species being eaten by striped bass in California,* it is not altogether unexpected. Scofield (*loc. cit.*, pp. 56, 57), has this to say: "Some questions regarding young chinook salmon as one of the foods of the bass have been repeatedly called to attention. During this investigation no salmon have ever been observed in the stomach of a bass. The lack of small salmon as a result of the serious depletion of this race is the probable reason none has been found in the stomachs of the voracious striped bass." A further point of interest resulting from the examination of the Waddell school of striped bass lies in their apparent selective feeding, kind of food depending upon size of fish.

Waddell Creek is a typical small coastal stream, located approximately twenty miles north of Santa Cruz. This stream has a well-developed lagoon, which is open during the winter months and ordinarily closed by a sand bar during most of the summer. During the spring of 1935, a school of striped bass was noticed near the upper end of the lagoon, in a deep hole (under the highway bridge), during the early part of March. Since Waddell Creek is being used by the California Trout Investigations as a stream for the study of the natural

* Mr. Charles Feller, wholesale fish dealer of Marshfield, Oregon, has sent to the writer a collection of young trout and salmon from the stomachs of six striped bass taken in the Coos Bay region, Oregon, in 1930 and 1931. The young salmon were practically all silver salmon 100-140 mm. (4-5½ in.) long, evidently seaward migrants. The dates that the fish were taken, April 28 and 29 and June 2, correspond to the period of migration of seaward migrant silver salmon in California. One salmon, partly digested, was apparently a king salmon. The trout contained were larger than the salmon, the largest being 212 mm. (about 8½ in.) long. These striped bass contained 10, 11, 14, 15, 20, and 22 trout and salmon fingerlings, respectively. Unfortunately data on the size of the striped bass were not obtained, but in a letter Mr. Feller states that bass weighing six to nine pounds appear to be the most voracious feeders, rather than the larger bass full of spawn.

propagation of trout and salmon and since it was thought that the striped bass might be interfering with the normal seaward migration of the young of these fishes, it was decided to seine out the bass.

On the morning of April 26 several seine hauls were made and nearly all (47) of the bass were netted. Table 1 shows the lengths and stomach contents of these bass, the number of times each item occurred, and the total number of each item. A plus sign (+) indicates that several (uncounted number) individuals of the item were present

TABLE 1

Stomach Contents of 47 Striped Bass, Waddell Creek Lagoon, April 26, 1935

Fish No.	Length fish in cm.	Salmon fingerlings	Salmonoid fingerlings	Salmonoid fry	Trout fingerlings	Sculpins	Sculpins (*Cottus*)	Gobies (*Eucyclogobius*)	Sticklebacks (*Gasterosteus*)	Unidentified fish remains	Scuds (*Gammarus*)	*Exosphaeroma*	*Corophium*	Caddisfly cases	Sand, debris	Empty
1	49					2										
2	48			1												
3	47		1				3									
4	46						3									
5	45		1													
6	44														+	
7	44						1			1						
8	43															+
9	43		2				2							2		
10	43		1													
11	43														+	
12	43															+
13	43					1				1	+					
14	42									1						
15	42				1	2										
16	42		2				1									
17	42															+
18	41														+	
19	41					1				1						
20	41	3														
21	41										1		1			
22	41									1	+		+			
23	40														+	
24	40							2			+					
25	38							1			+					
26	37	2														
27	37							1			+					
28	31								2	3						
29	31								1			+				
30	26										+		+			
31	26										+					
32	26										+					
33	26							4			+					
34	26										+					
35	25							1			+					
36	25							1			+					
37	25										+	+				
38	25										+	+				
39	25										+	+	+			
40	24										+	+				
41	24							5			2		2			
42	23										+					
43	23										2		8			
44	22										+		+			
45	21							3			+					
46	20										+				+	
47	20							3			1					
Number of times item occurred	.....	2	5	1	1	4	5	9	2	6	24	5	7	1	5	3
Number of each item	.....	5	7	1	1	6	10	21	3	8	+	+	+	2	+	+

Plus sign indicates several (uncounted number) individuals.
1 inch=2.54 centimeters (cm.).
=25.4 millimeters (mm.).

in the stomach. Figure 64 gives a graphic representation in percentages of the types of food that the bass were eating.

It is interesting to note from Table 1 that the larger striped bass had been feeding largely on salmon, trout, and sculpins (cottoids, bullheads), while the smaller bass had been feeding almost entirely on small crustaceans and the small sticklebacks (*Gasterosteus*) and gobies (*Eucyclogobius*). Six of the larger 22 bass had stomachs that were empty or contained only sand and debris, but all of the others with the exception of one had been eating fish and only four had anything except fish in their stomachs. Eight of these larger fish had trout or salmon in their stomachs. Several of the eight and some of the others contained sculpins.

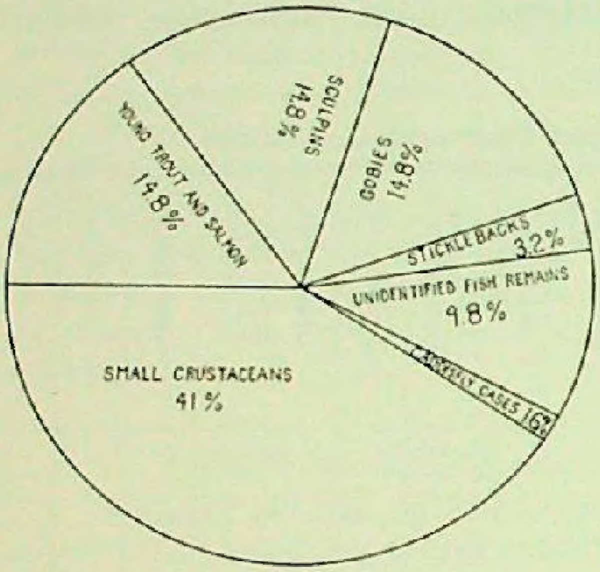


FIG. 64. Percentages based on number of times of occurrence of types of food eaten by 47 striped bass seined from Waddell Creek lagoon April 26, 1935.

Of the twenty-five smaller bass, one had an empty stomach and all the rest but two had been feeding on small crustaceans (*Gammarus*, *Corophium*, and/or *Exosphaeroma*). And of these twenty-five only one had fish other than sticklebacks and gobies in its stomach. This is indeed a remarkable case of selective feeding, especially in view of the fact that the fish had remained as one school in the one hole for over a month. It is clearly brought out by Figure 65.

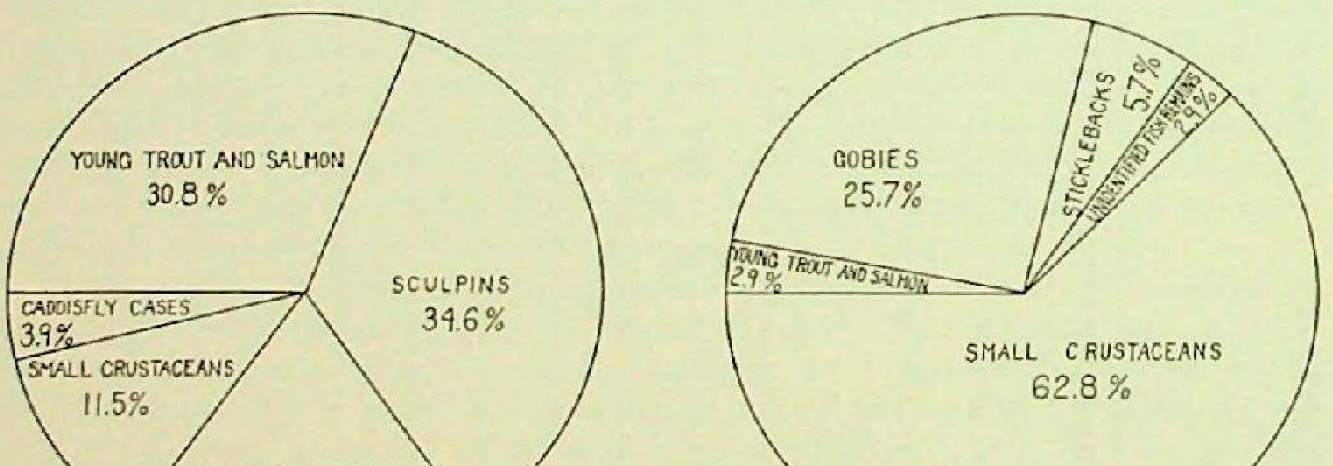


FIG. 65. Percentages based on number of times of occurrence of types of food eaten by the larger (left diagram) and by the smaller (right diagram) of 47 striped bass seined from Waddell Creek lagoon April 26, 1935.

It is of importance to note that the striped bass were present in the stream just about the time of the beginning of the seaward migration of the fingerling silver salmon and steelhead and that they were in a position in which they could intercept all of these fish. The exact time of the migrations of the young trout and salmon in Waddell Creek is

known through the operation of a trap which detains fish moving up or down the creek.

Striped bass have entered Waddell Creek in various years. Scofield (*loc. cit.*) was not inclined to consider these or other striped bass found along the coast south of San Francisco Bay as a population separate from the striped bass of the San Francisco Bay region on the basis of seine hauls made in Salinas River and Waddell Creek during May, 1927. These seine hauls revealed (1) the absence of ripe bass (during what in other localities is the height of the spawning season) and the absence of small fry which would be the result of a spawning in this area and (2) the presence of only the second, fifth, sixth, seventh, and eighth year classes and the total absence of the third and fourth year classes.

The first contention is not entirely correct, in that in the present series of examinations, although the sexual products in most of the bass were in an immature stage, one of the males (48 cm.) possessed large, white testes, from which a little milt was obtained.

The second point is entirely disproved by the examination of the present series of bass. Over one-half of the forty-seven fish caught were of the third and fourth year classes, with the possibility that several of the larger fish were of the fifth year class.

At this time it might be interesting to include records of two one-year old bass seined in Waddell Creek lagoon on April 26, 1932, by J. H. Wales and the writer. The records are as follows:

	No. 1	*No. 2*
Standard length	98 mm.	98 mm.
Length to fork of caudal	114 mm.	113 mm.
Stomach contents	*Corophium* 24, *Gammarus* 4	*Corophium* 17, *Neomysis* 1, Midge larva 1.

Corophium, *Gammarus*, and *Neomysis* are small crustaceans.

A. C. Taft and J. H. Wales also seined in Waddell Creek lagoon, on November 24, 1931, and in one of several seine hauls obtained two dozen striped bass, as well as finding a large, dead striped bass. Measurements were not made of these striped bass but Mr. Taft says they were of approximately the same size composition as those shown in Table 1. An examination of the stomachs of ten of these bass revealed them to be entirely empty.

At what time of year the above bass entered Waddell Creek must of course remain a matter of conjecture. Since the mouth of the creek opened on November 13, following the first fall rains, they could have come in at this time, or they may have remained in the lagoon over the summer, while the lagoon was closed.

The writer also found a small dead striped bass (length 260 mm.) in Waddell Creek lagoon on March 23, 1934.

Food of Striped Bass in the San Francisco Bay Region

During the spring of 1935 Mr. H. B. Nidever of the Bureau of Commercial Fisheries collected a series of stomachs of striped bass taken in San Francisco Bay and adjacent waters by hook and line. These were examined by Mr. G. H. Clark of the same bureau, who has kindly

turned over the data to the writer. These data are shown in Table 2. It will be noticed that most of the stomachs were empty and that several of those not empty contained material undoubtedly being used as bait (sardine heads and herring). It is interesting to note that most of these fish were collected about the same time as the series of fish from Waddell Creek lagoon.

Scofield (*loc. cit.*) lists the feeding of the striped bass as being "the heaviest between April and the following October." The above series of empty stomachs, taken mostly in April and May, shows that this is not always the case. However, the fact that the fish were taken by hook and line may be a factor, in that the fish caught may have been the particular individuals that were hungry and therefore taking bait, out of a large number of fish present.

Further evidence that striped bass do not always feed during the summer months is contained in the report of Edwin Linton (1901). He writes: "The stomachs of all the specimens which I have examined have been empty. A few fish scales have been noted in the intestine."

TABLE 2

Stomach Contents of 43 Striped Bass from San Francisco Bay and Adjacent Waters, March 28 to May 15, 1935

No. and locality	Date	Length	Weight	Sex	Stomach contents
1. Brick Yard, Sac. R.	3/28/35	18 in.			1 fish vertebra 3 in. long
2. Brick Yard, Sac. R.	4/ 1/35	18 in.		M	1 head and ½ body of herring
3. Pt. Richmond	4/ 3/35		4½ lbs.		One 10 in. Jack Smelt; seven smelt 3.5 in. to 5 in.; one perch 5.5 in.; scales of 4 yr. Striped Bass
4. Pittsburg	4/10/35	20 in.	4 lbs.	M	Empty
5. Pittsburg	4/10/35	21 in.	4 lbs.		5 in. Striped Bass
6. Pittsburg	4/10/35	24in.(?)	9 lbs.		Empty
7. Pittsburg	4/10/35	22 in.	4 lbs.	F	Empty—tumor on stomach
8. Pittsburg	4/10/35	24 in.	5 lbs.		Empty
9. Pittsburg	4/10/35	22 in.	4 lbs.	M	Empty except for small piece of tule
10. Pittsburg	4/10/35	21 in.	3¾ lbs.	M	Empty
11. Pittsburg	4/10/35		4½ lbs.		Empty
12. Pittsburg	4/10/35		8 lbs.		5 in. two-dorsaled fish
13. Pittsburg	4/10/35				3 in. head of sardine or herring
14. Pittsburg	4/10/35				Empty
15. Pittsburg	4/10/35				Empty
16. Pittsburg	4/10/35	20 in.	3½ lbs.	M	Empty
17. Pittsburg	4/10/35	21 in.		M	Empty
18. Pittsburg	4/10/35				Empty
19. Pittsburg	4/10/35				Empty
20. Pittsburg	4/10/35	22 in.		M	Empty
21. Pittsburg	4/10/35	22 in.	4 lbs.	M	Empty
22. Pittsburg	4/10/35				Empty
23. Honker Bay	4/15/35				Empty
24. Above Dutch Slough	4/19/35		10 lbs.		Empty
25. Pittsburg	4/19/35		4 lbs.		Empty
26. Antioch Bridge	4/19/35		7½ lbs.		Empty
27. (?)	(?)				Empty
28. Broad Slough	4/19/35		3½ lbs.		Empty
29. Berkeley Flat	4/25/35		5 lbs.		Three 4 in. Striped Bass; four smelt; three anchovies
30. Rio Vista	4/27/35		5 lbs.		Empty
31. Rio Vista	4/30/35	12 in.			Empty
32. Rio Vista	4/30/35		11 lbs.		Empty
33. Sacramento River, Mouth Feather River	5/1-15/35				Sardine head
33. Sacramento River, Mouth Feather River	5/1-15/35				Sardine head and body; small unidentified fish head
35. Sacramento River, Mouth Feather River	5/1-15/35				Piece of weed and 3 Striped Bass scales
36. Sacramento River, Mouth Feather River	5/1-15/35				Empty
37. Rio Vista	5/ 1/35		10 lbs.		Empty
38. Rio Vista	5/ 5/35		6 lbs.		Empty except for ½ crab
39. Rio Vista	5/ 5/35		4½ lbs.		Empty
40. Mouth American River	5/ 5/35		7 lbs.		Remains of two sardine heads and napes
41. Rio Vista	5/ 6/35		9 lbs.		Empty
42. Rio Vista	5/10/35		11½ lbs.		Empty
43. Rio Vista	5/14/35		9½ lbs.		Empty

All of the specimens of striped bass mentioned by Linton were collected from July 14–August 18, 1886–1900, in the Woods Hole region, off the coast of Massachusetts.

Published Accounts of the Food of the Striped Bass

At this point it might be valuable to summarize and review our knowledge of the food of the striped bass, as contained in previously published articles both in California and on the Atlantic coast. Papers referred to here will be found listed more fully in the bibliography at the end of this article.

Food on the Atlantic Coast

A. E. Verrill (1873, p. 514) makes the following notes:

"At Great Egg Harbor, New Jersey, April, 1871, several specimens, freshly caught in seines, with menhaden, &c., contained *Crangon vulgaris* (shrimp) in large quantities.

"A specimen caught at Wood's Hole, July 22, 1872, contained a large mass of 'sea-cabbage,' *Ulva latissima,* and the remains of a small fish.

"Specimens taken at Wood's Hole, August, 1871, contained crabs, *Cancer irroratus;* and lobsters, *Homarus Americanus.*"

On p. 73, Spencer F. Baird (1889) says the following:

"There are comparatively few fishes within our knowledge that certainly eat sea-weed as a portion of their food, although it is said that the stomach of the striped bass frequently contains such quantities of ulva and other succulent vegetation as to render it almost certain that it must have taken it as an article of food. Not unfrequently the vegetable contents of the stomachs of certain fishes may have been taken in accidentally in connection with some shrimp or mollusk which was resting upon it at the time of capture."

Gideon Mosher (1883), who at the time had been engaged in the bass fishery for 45 years, 30 or 40 years of which he had been in the habit of preparing bass for market, claimed that striped bass do not feed on menhaden. Out of tens of thousands of striped bass he had prepared, he had never found menhaden in them, unless it had been fed to them for bait. He further observes that bass fishing is best where crabs and lobsters are most plentiful.

A U. S. Bureau of Fisheries Memorandum, quoted by Scofield and Bryant (1926), makes the following statement: "The striped bass is reputed to be a voracious fish preying largely upon smaller fishes, and is particularly abundant at the time of the spring runs of shad and alewives or river herring. At this season it is well fed and plump. To some extent it frequents the rocky shores and beaches of bays and sounds at high tide in search of crabs, shrimp and other food, and, at the mouths of creeks, smaller individuals lie in wait for the schools of smaller fishes and crustaceans which supply them with food. It also subsists upon mollusks, sea worms, etc."

The present writer wishes to call attention to the part in the above passage which reads: "The striped bass * * * is particularly abundant at the time of the spring runs of shad and alewives or river herring." We do not have alewives in California, but the shad, intro-

duced from the Atlantic coast, is a well-established resident of the Sacramento River, so that the above quotation may have a direct bearing on the situation in our state. During the past two years considerable numbers of young shad have been reported, on reliable authority, as occurring in the stomachs of striped bass taken in the Sacramento River and adjacent waters, between February and May.

Food on the Pacific Coast

Leaving the Atlantic coast and examining reports from California, we find the following accounts. Hugh M. Smith (1896, p. 454) reported:

"The introduced carp appears to be the principal food of the striped bass in California, and in the fresh waters is the almost exclusive food. Mr. Babcock has opened hundreds of bass for the purpose of ascertaining the nature of their food, and has never seen any other fish than carp in their stomachs. He has heard, however, of small catfish being found in them. Mr. Alexander's examination of many bass in the San Francisco market showed that whenever food of any kind was present in the alimentary tract it was in nearly every instance carp. A 10-pound carp is said to have been found in the stomach of one bass. His conclusions are that, taking the season through, carp will be found in the stomachs of 7 out of every 10 bass sold in San Francisco or caught in the rivers.

"At Capitola, on Monterey Bay, crabs have been taken from the stomachs of bass, and it is probable that in the salt water a great variety of fish food is ingested."

These statements seem rather surprising and difficult to take literally, in the light of more recent examinations. Since there are still a great many carp in the Sacramento River, one would think that they would be encountered in the stomachs of striped bass in approximately the same frequency as formerly, but the records do not show this, and conversely, one would think that Alexander in the course of examination of "hundreds of bass" would have found at least a few split-tails, hardheads, Sacramento pike, or other native minnows or fresh-water sculpins (cottoids) in their stomachs. Also, at the time of Alexander's report the salmon were still abundant in the Sacramento River, so it is surprising that at least a few were not encountered in the stomachs examined by Alexander.

Scofield and Coleman (1910, p. 114) list the food of the adult striped bass in the rivers as mainly carp, hardheads, and split-tails and say that the fishermen claim that when the carp is plentiful it is their principal food.

Concerning the food of young bass, they have this to say:

"An examination of the stomachs of fifty young bass averaging 3 inches in length, which were taken at 'Morrison's Bite' in Napa Creek on September 10, 1908, shows the following contents: Crustaceans, a species of Mysis, 30 per cent; of young shrimp, 15 per cent; of a species of Gammarus, 1 per cent; of an Isopod, 1 per cent; and 1 small crab. Marine worms or annelids, a species of Nereis, 45 per cent; of species not recognizable, 5 per cent; small fish, species not recognizable, 2 per cent.

"It will, therefore, be seen that on this feeding ground, at least, marine worms comprise 50 per cent of the food, crustaceans of marine species 48 per cent. and small fish only 2 per cent. The young shrimp and young fish were taken from the stomachs of young bass of 3 or 4 inches in length and the other small crustaceans from the stomachs of specimens 3 inches and under in length, showing that the young bass begin feeding on the small species of crustaceans and worms, and as they grow in size are able to take the shrimp and young fish."

Evidently there was an error in the identification of the small crustaceans listed as Mysis. *Mysis relicta*, a fresh-water form that occurs typically in deep lakes, is the only species of *Mysis* found in North America, and the crustaceans listed by Scofield and Coleman were likely *Neomysis*, a typically brackish water form that is common in Waddell Creek lagoon and in other coastal stream lagoons. *Neomysis* was found in the stomach of a young striped bass taken in Waddell Creek lagoon in 1932 by J. H. Wales and the writer. *Gammarus* is also a fresh or brackish water form and should not be listed as a marine crustacean.

Scofield and Bryant (1926) say that fishermen occasionally find a dead striped bass with a catfish caught in its throat by the spines and also that catfish weighing up to two pounds appear to be a common item in the diet in the sloughs.

E. C. Scofield (1928.2, p. 37) has this to say: "* * * We have found that the migrations or movement of the bass within the bay (San Francisco) and along the coast are largely dependent upon the food they are seeking. During the warm summer months the bass school on the mud flats. There, also, is the small feed of these ravenous eaters. In the fall, when the cold weather sets in, they leave the flats, and with them go the smaller fishes."

Quoting further: "* * * A wide variety of foods has been found in their stomachs. Crabs and shrimps are their main diet, but we have found that they eat almost anything they can get into their mouth lengthwise. Any food that is plentiful, such as crab and shrimp, appears to be their favorite. Small smelt occur in great numbers in the summer months and they are ravenously eaten by the bass. We once extracted a thirteen-inch split tail from a nineteen-inch bass. Exceptionally large crabs, smelt and bullheads are not uncommon in their stomachs. They eat their own young in great quantities. Other varieties of food removed from their stomachs are softshell crabs, clams, periwinkles, piling worms, herring, gobies, minnows, sticklebacks, sand fleas and grass. Bass will follow a school of fish for miles if the water is clear. Where there are sea gulls and pelicans flying over the water, one is sure to find a school of small fish, and there also will always be a school of feeding bass."

In his other paper of the same year (1928.1) Scofield largely covers the material contained in the above-quoted paper and in his bulletin of 1931 (Scofield 1931).

In the latter paper he makes the note that the study of the food of the striped bass was given a minor consideration in the report, only the essential facts of their feeding habits being covered. The material contained on the food of the striped bass in the latter paper may be summed up as follows:

1. The striped bass are voracious eaters. Practically every marine form common to the San Francisco Bay region has been found in their stomachs. Their food includes fishes, such as small Pacific herring, smelt, anchovies, split-tails, striped bass, shad, gobies, carp, and perch; crustaceans and mollusks: crabs, shrimps, periwinkles, clams; and various other forms such as worms, copepods and *Velella*.

2. Bass feed heaviest during the spring and summer months. Spawning bass feed while on their spawning beds.

3. The bass feed heavier in the salt water.

Bait Taken by Striped Bass

Almost every variety of live and dead bait has been used at various times to successfully catch striped bass. This list includes sardines, clams, bullheads, drawings from wild ducks, breasts of mud hens and skinned small birds such as linnets, sparrows, etc., live split-tail and Sacramento pike, etc. One writer claims catching a bass on a watch and another mentions cleaning a bass that contained a chicken foot in its stomach.

Feeding Habits of Striped Bass

Concerning the feeding habits of the striped bass, Hubback (1927) has the following interesting account:

"Several curious experiences have convinced me that bass are able to cast a phosphorescent glow when feeding at night. I was camping by a brackish lagoon one very dark night when I heard a bass rush something in the weeds not more than ten feet from where I was sitting. Naturally, I watched the place from which the noise came, and was amazed to see a glow on the water, sufficient to enable me to see the outline of the weeds and grass clearly, and even the bubbles on the water three or four inches from the light. After the glow I heard the fish rush and make that popping or sucking sound. The entire performance was repeated six times. Another time, about the same thing happened to me on the Salinas River. I should be glad to hear from others on this subject as I was afraid of being doubted, so hesitated to tell of my experience."

BIBLIOGRAPHY

Baird, Spencer F.
1889. The sea fisheries of eastern North America. Appendix A to Report U. S. Fish Com. 1886 (1889), pp. 3–224. Esp. Sect. F—"The natural food of sea fish," pp. 72–80.

Hubback, C. E.
1927. Striped bass as I know them. Calif. Fish and Game, Vol. 13, No. 1, pp. 25–27.

Linton, Edwin
1901. Parasites of fishes of the Woods Hole region. Bull. Bur. Fish. 1889 (1901), Vol. 19, pp. 405–492.

Mosher, Gideon
1883. Do striped bass (*Roccus lineatus*) feed on menhaden. Bull. Bur. Fish. 1883 (1883), Vol. 3, p. 410.

Scofield, E. C.
1928.1. Preliminary studies on the California striped bass. Trans. Amer. Fish. Soc., Vol. 58, 1928, pp. 139–145.
1928.2. Striped bass studies. Calif. Fish and Game, Vol. 14, No. 1, pp. 29–37.

1931. The striped bass of California (*Roccus lineatus*). Calif. Fish. Bull. No. 29, 1931, 84 pp.

Scofield, N. B., and Bryant, H. C.
1926. The striped bass in California. Calif. Fish and Game, Vol. 12, No. 2, pp. 55-74.

Scofield, N. B., and Coleman, G. A.
1910. Notes on spawning and hatching of striped bass eggs at Bouldin Island Hatchery. Report Calif. Fish and Game Com. 1907–1908. (Appendix to Report for 1909–1910), pp. 109–117.

Smith, Hugh M.
1896. A review of the history and results of the attempts to acclimatize fish and other water animals in the Pacific States. Bull. Bur. Fish. 1895 (1896), Vol. 15, pp. 397–472, pls. 73–83.

Verrill, A. E.
1871. On the food and habits of some of our marine fishes. Amer. Naturalist, 1871, Vol. 5, pp. 397–400. Canadian Naturalist, Vol. 6, pp. 107–111.
1873. Report upon the invertebrate animals of Vineyard Sound and the adjacent waters, with an account of the physical characters of the region. Report U. S. Fish. Com. 1871–72 (1873), pp. 295–778. Esp. section on "Lists of species found in the stomachs of fishes-food of fishes," pp. 514–521.

A SECOND REPORT ON STRIPED BASS TAGGING [1]

By G. H. Clark

In 1934, a preliminary report [2] was made on striped bass when 689 fish had been tagged and 42 recoveries made. As stated therein, no definite migrations were apparent from the small amount of tagging done up to that time. The aforementioned report recorded in detail how the fish were tagged, type of tag used and other essential information.

Since the above named paper was published, 855 more striped bass have been tagged, making a total of 1544 fish. Of this entire number, anglers tagged 600 and the Division of Fish and Game 944, about a 40–60 ratio. One hundred and ninety-nine fish were tagged in 1932, 496 in 1933, 722 in 1934, and 127 in 1935. (See Tables I and IV.) The sizes tagged ranged from 5 to 41 inches with an average size of 11.86 inches. Twenty-five per cent of the striped bass tagged were 10 inches or less, 50 per cent were more than 10 inches, and 25 per cent were over 13 inches, but only 1 per cent was 20 inches or greater.

All fish were caught by hook and line, except two which were taken with a seine in Elkhorn Slough in Monterey County. Table III shows in condensed form the number of bass tagged in twelve various localities (see Fig. 66) and the percentage of the total tagging that was done in each area.

There were 151 tagged bass recovered up to and including December 31, 1935 (see Tables I and III), about a 10 per cent (9.78) return of all fish. Those fish tagged in 1932 had almost a 17 per cent return, those in 1933 a 10 per cent recovery, those in 1934 a 9 per cent recapture, and in 1935 about 1½ per cent. A large majority of the fish were tagged in the fall months from August to December, but recaptures were made throughout the year. The time elapsing between release and recapture ranged from 4 to 477 days, with an average of 111 days. The distances traveled by bass varied from nothing to 46 miles, with an average of 10.6 miles between points of release and recovery. There is no definite relationship between the elapsed time from release to capture and the distance traveled, in fact the two fish which were free the longest, almost 16 months, were recaptured in the same locality as tagged and the bass that traveled the farthest (46 miles) did so in 2½ months.

The sizes, at time of tagging, of recovered striped bass are shown in Table IV. It is to be expected that the largest number of recoveries would correspond to the same size as the largest number tagged. Agreement between size of tagged fish and recovered fish is fairly good, in that the peaks are nearly the same, at 10 inches, 15 inches

[1] Contribution No. 156 from the California State Fisheries Laboratory, July, 1936.

[2] Clark, G. H. Tagging of striped bass. Calif. Fish and Game, vol. 20, no. 1, pp. 14-19, 1934.

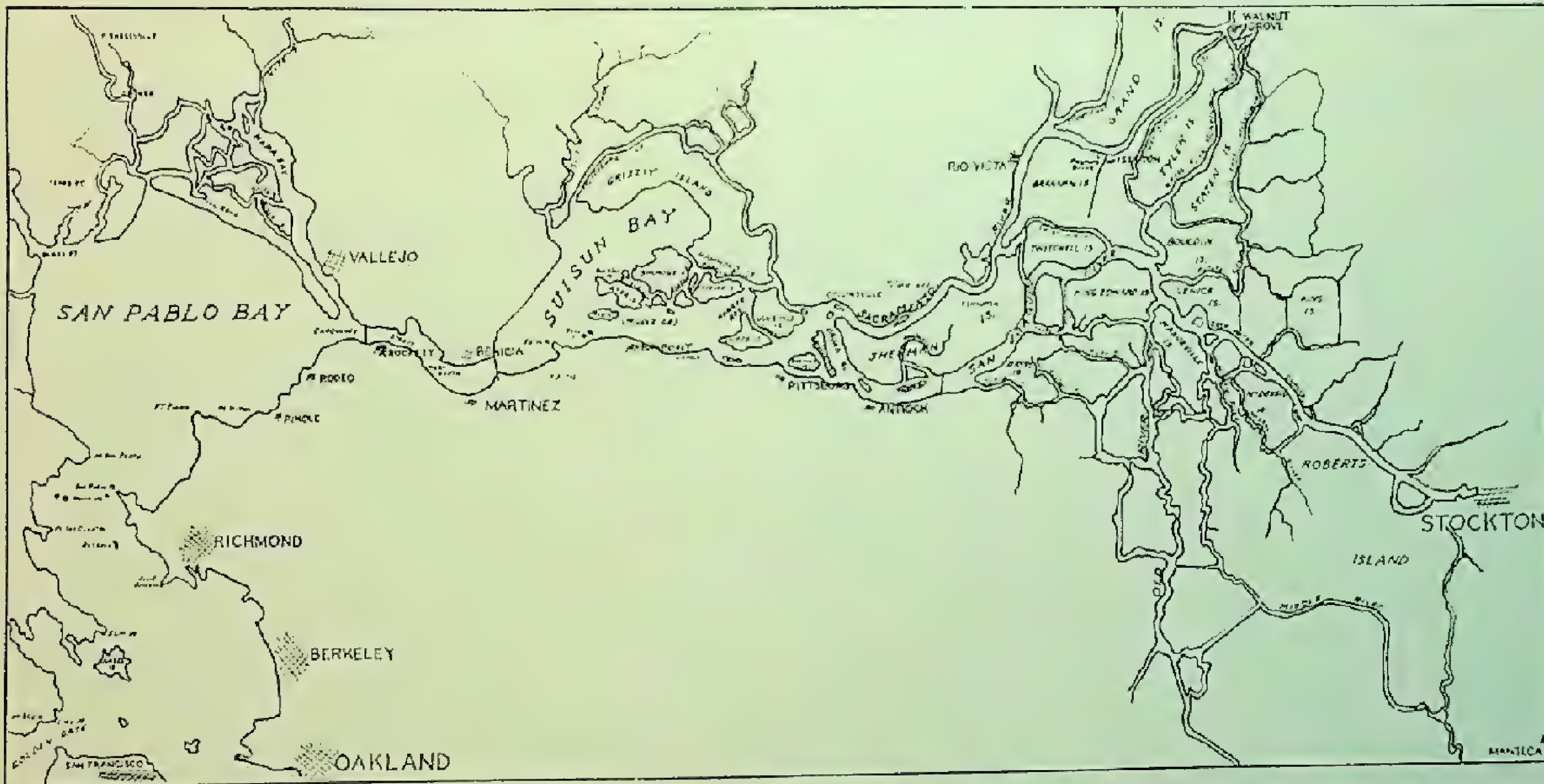


FIG. 66. Map of the San Francisco Bay and the Sacramento and San Joaquin rivers, showing the regions where the striped bass tagging was done and most of the recoveries were made.

and 19 inches. However, the recovered fish are not in the same proportion in relation to the total as are the tagged fish. For instance, 23 per cent of the fish tagged were 10 inches long but only 17 per cent of the recovered fish were in the 10-inch group. The reverse is true at 15 inches. This length category comprised 5 per cent of the tagged bass and 9 per cent of the recaptured fish. There is no relation between the size of the fish when tagged and the distance traveled or between size and elapsed time before recapture.

It is apparent from the summarized account of tagging and recoveries, as given in Table III, that certain characteristics are common to most of the localities. Of the 151 recoveries, 101 or 67 per cent were made outside the locality in which they were tagged. However, there is no definite migration from one region to another or no indication that fish tagged in a given area moved in the same direction or to the same locality; rather the opposite occurred, in that the bass moved and dispersed in all directions and into all areas. However, it is noted that although a little less than half the fish moved out of the Napa River locality only two fish went into the Napa River from other areas.

A study of the bass tagged and recovered so far indicates no definite migrations, simply a diffusion from the locality in which the bass were tagged. Future work should include tagging of larger numbers throughout the year and in widely scattered localities, and if possible some tagging to the north and south of San Francisco Bay and river areas, such as the Salinas River, Elkhorn Slough, and Russian River.

TABLE I

Striped Bass. Tagged, 1932-1935

Number of bass tagged	Tag numbers	Date	Locality	Tagged by
5	1-5	9/20/32	South Hampton Bay, Carquinez Strait	Division
9	6-14	9/20/32	Middle Ground, Suisun Bay	Division
36	15-50	9/21-32	Middle Ground, Suisun Bay	Division
5	51-55	10/27/32	Mile above R.R. bridge, Suisun Bay	Division
44	*56-100	10/27/32	Middle Ground, Suisun Bay	Division
8	101-108	10/28/32	Off Snag Island, Middle Ground, Suisun Bay	Division
8	109-116	10/28/32	Middle Ground, Suisun Bay	Division
34	117-150	10/28/32	Mile above R.R. bridge, off Avon Wharf, Suisun Bay	Division
10	151-160	11/11/32	Mouth of Andy Mason Slough, Suisun Bay	Sportsmen
3	161-163	11/12/32	West of Wheeler Island and east of Noyce Slough, Suisun Bay	Sportsmen
3	164-166	11/13/32	Mouth of Andy Mason Slough, Suisun Bay	Sportsmen
1	172	4/15/33	San Pablo Bay	Sportsmen
1	173	6/20/33	Point Wilson	Sportsmen
3	174-176	6/22/33	South Hampton Bay, Carquinez Strait	Sportsmen
4	177-180	8/26/33	Antioch Bridge	Sportsmen
1	181	11/24/32	Boynton Slough, Suisun Bay	Sportsmen
1	182	2/ 5/33	Suisun Slough	Sportsmen
2	183-184	9/27/33	Suisun Slough	Sportsmen
4	185-188	9/28/33	Suisun Slough	Sportsmen
1	189	11/24/33	Suisun Slough	Sportsmen
1	190	9/27/33	Suisun Slough	Sportsmen
10	231-240	12/ 3/32	Between Ryer and Roe Island, Suisun Bay	Sportsmen
10	241-250	12/ 4/32	Grizzly Bay	Sportsmen
5	251-255	12/ 4/32	Between Ryer and Roe Island, Suisun Bay	Sportsmen
5	256-260	5/13/33	Petaluma Beacon, Napa River	Sportsmen
4	261-264	5/14/33	Petaluma Beacon No. 2, Napa River	Sportsmen
6	265-270	6/11/33	Steamboat Slough	Sportsmen
2	271-272	11/11/33	Middle Ground, Suisun Bay	Division
6	273-278	11/11/33	Broad Slough	Division
1	292	7/29/33	Towers, Napa River	Sportsmen
8	293-300	10/19/33	Towers, Napa River	Sportsmen
4	301-304	3/ 6/34	Tiberon	Sportsmen
1	305	3/ 8/34	Tiberon	Sportsmen
1	306	3/ 8/34	Chicken Point	Sportsmen
3	307-309	3/10/34	Marin Islands	Sportsmen
4	310-313	9/18/34	China Camp	Sportsmen
2	314-315	9/28/34	China Camp	Sportsmen
1	316	9/29/34	China Camp	Sportsmen
1	317	10/11/34	San Quentin Ferry	Sportsmen
3	318-320	10/25/34	Wingo	Sportsmen
7	*321-328	11/13/34	Napa River	Sportsmen
1	330	12/29/34	Marin Islands	Sportsmen
10	331-340	10/25/34	Wingo	Sportsmen
1	341	12/29/34	Marin Islands	Sportsmen
1	342	12/29/34	San Quentin	Sportsmen
1	343	12/29/34	Marin Islands	Sportsmen
1	344	12/29/34	San Quentin	Sportsmen
4	345-348	3/18/35	San Quentin	Sportsmen
1	349	3/20/34	Marin Islands	Sportsmen
1	350	3/18/35	San Quentin	Sportsmen
1	351	5/27/33	Beacon No. 2, Napa River	Sportsmen
16	352-367	5/27/33	Towers, Napa River	Sportsmen
12	368-379	5/28/33	Towers, Napa River	Sportsmen
1	380	5/29/33	Beacon No. 2, Napa River	Sportsmen
1	381	6/10/33	Towers, Napa River	Sportsmen
1	383	6/10/33	Ratto's Barn, Napa River	Sportsmen
4	384-387	6/11/33	Ratto's Barn, Napa River	Sportsmen
1	388	6/17/33	Cutting Wharf, Napa River	Sportsmen
1	389	7/ 1/33	Mouth of South Slough, Napa River	Sportsmen
2	390-391	7/ 4/33	Beacon No. 8, Napa River	Sportsmen
19	392-410	7/29/33	Towers, Napa River	Sportsmen
4	411-414	10/ 8/33	Beacon No. 2, Napa River	Sportsmen
1	415	4/21/34	Ring Point, Marin County	Sportsmen
2	416-417	10/26/35	Pittsburg	Sportsmen
1	441	8/19/33	Towers, Napa River	Sportsmen
47	451-497	10/17/33	Broad Slough	Division
58	498-555	10/18/33	Point of Chipps Island, Honker Bay	Division
60	*556-616	10/19/33	Point of Chipps Island, Honker Bay	Division
14	617-630	10/19/33	Broad Slough	Division
2	631-632	11/19/33	Fly Bay, Napa River	Sportsmen
1	633	2/11/34	Sonoma Creek Junction, Napa River	Sportsmen
1	634	2/11/34	Sonoma Slough	Sportsmen
1	635	3/20/34	Off Bombing Base, Marin County	Sportsmen
2	636-637	7/29/34	Montezuma Slough at Grizzly Island Ferry	Sportsmen
2	638-639	8/24/34	Montezuma Slough and Frost Slough	Sportsmen
1	640	8/24/34	Mouth of Montezuma Slough	Sportsmen

* Tags 70, 326, 610, 661, 904 and 1407 lost.

TABLE I Continued

Striped Bass. Tagged, 1932-1935

Number of bass tagged	Tag numbers	Date	Locality	Tagged by
8	641–648	8/25/34	Mouth of Montezuma Slough	Sportsmen
12	649–660	8/25/34	Grizzly Bay off Suisun Cutoff	Sportsmen
19	*662–680	9/ 3/34	Black Can Buoy, Napa Bay	Sportsmen
21	681–701	11/ 7/33	Off Browns Island, near Pittsburg	Division
1	702	11/ 8/33	Middle Slough	Division
142	703–844	11/ 8/33	Grizzly Bay	Division
42	845–886	11/ 9/33	Grizzly Bay	Division
2	887–888	12/ 8/33	Elkhorn Slough, Monterey County	Division
3	889–891	7/10/34	Off Pittsburg, New York Slough	Division
7	892–898	7/11/34	Grizzly Bay, off AndyMason Slough	Division
2	899–900	7/11/34	Grizzly Bay	Division
1	901	11/24/33	Suisun Slough	Sportsmen
1	902	1/ 1/34	Suisun Slough	Sportsmen
7	*903–910	9/16/34	Suisun Slough	Sportsmen
1	921	6/17/34	Banta Carbona, San Joaquin River	Sportsmen
4	922–925	4/ 3/34	Carbona District, East of Tracy, San Joaquin River	Sportsmen
4	926–929	6/17/34	Banta Carbona, San Joaquin River	Sportsmen
2	981–982	7/11/34	Grizzly Bay	Division
8	983–990	7/11/34	Off Ryer Island, Suisun Bay	Division
3	991–993	7/12/34	Back of Seal Island, Suisun Bay	Division
6	994–999	10/15/34	Broad Slough	Division
15	1000–1014	8/17/34	Above Sears Toll Road, Napa River	Sportsmen
5	1015–1019	8/29/34	Between Beacon and Towers, Napa River	Sportsmen
3	1040–1042	8/21/34	Rio Vista, Sacramento River	Sportsmen
1	1043	8/28/34	Emmaton, Sacramento River	Sportsmen
6	1044–1049	8/31/34	Sherman Island, Emmaton, Sacramento River	Sportsmen
3	1050–1052	8/29/34	BetweenBeacon No. 1 and Towers, Napa River	Sportsmen
17	1053–1069	9/ 5/34	Between Beacon No. 1 and Towers, Napa River	Sportsmen
1	1070	9/22/34	Grizzly Bay	Sportsmen
1	1071	9/ 8/34	Cutting's Wharf, Napa River	Sportsmen
6	1072–1077	9/ 9/34	Mouth of Steamboat and Napa River	Sportsmen
5	1078–1082	9/ 9/34	Off Beacon No. 2, Napa Bay	Sportsmen
4	1083–1086	9/ 9/34	Mouth of Napa and Fagans Slough	Sportsmen
2	1087–1088	9/22/34	Grizzly Bay	Sportsmen
6	1089–1094	9/22/34	Cutoff Slough	Sportsmen
2	1095–1096	9/22/34	Slough between Point Buckler and Simon's Island	Sportsmen
3	1097–1099	9/22/34	Mouth slough at Point Buckler and Grizzly Bay	Sportsmen
2	1100–1101	10/13/34	Sycamore Park, Sacramento River	Sportsmen
1	1102	3/ 5/35	Training Ship, California City	Sportsmen
1	1103	3/19/35	Off San Quentin Point	Sportsmen
1	1104	4/28/35	Beacon No. 2, Napa River	Sportsmen
1	1105	4/28/35	Fagans Slough, Napa River	Sportsmen
2	1106–1107	4/28/35	Ratto's Barn, Napa River	Sportsmen
6	1108–1113	5/ 5/35	Ratto's Barn, Napa River	Sportsmen
4	1114–1117	10/ 6/35	Montezuma Slough at Grizzly Island Ferry	Sportsmen
1	1118	10/13/35	Grizzly Bay at mouth of Montezuma Slough	Sportsmen
1	1120	9/22/34	Mouth of slough at Point Buckler and Grizzly Bay	Sportsmen
8	1121–1128	9/23/34	Grizzly Bay	Sportsmen
11	1129–1139	9/22/34	Mouth of slough at Point Buckler and Grizzly Bay	Sportsmen
14	1170–1183	9/12/34	Above Toll Road, Napa River	Sportsmen
3	1184–1186	9/26/34	Above Toll Road, Napa River	Sportsmen
13	1187–1199	9/26/34	Between Beacon No. 1 and Towers, Napa River	Sportsmen
11	1200–1210	9/19/34	Grizzly Bay	Sportsmen
4	1211–1214	9/19/34	Point Buckler	Sportsmen
6	1215–1220	9/26/34	Grizzly Bay	Sportsmen
2	1221–1222	10/ 3/34	Middle Ground, Suisun Bay	Sportsmen
1	1223	10/ 5/34	Middle Ground, Suisun Bay	Sportsmen
1	1224	10/17/34	Bay Point, Middle Ground, Suisun Bay	Sportsmen
1	1225	10/17/34	Off Freman Island	Sportsmen
3	1226–1228	10/17/34	Middle Ground, Suisun Bay	Sportsmen
2	1229–1230	10/24/34	Middle Ground, Suisun Bay	Sportsmen
6	1231–1236	9/24/34	Middle Ground, Suisun Bay	Sportsmen
3	1237–1239	11/20/34	Buckler Point	Sportsmen
8	1240–1247	11/ 7/34	Buckler Point	Sportsmen
1	1260	2/16/35	Suisun Creek	Sportsmen
3	1261–1263	2/22/35	Suisun Creek	Sportsmen
2	1264–1265	2/26/35	Suisun Creek	Sportsmen
1	1266	2/27/35	Suisun Creek	Sportsmen
15	1270–1284	10/ 3/34	Above Antioch Bridge, Big Break	Sportsmen
11	1285–1295	10/17/34	Above Toll Road, Napa River	Sportsmen
4	1296–1299	11/ 7/34	Between Beacon No. 1 and Towers, Napa River	Sportsmen
9	1300–1308	10/15/34	Broad Slough	Division
42	1309–1350	10/15/34	Big Break, Sherman Island	Division
7	1351–1357	10/16/34	Middle Slough, near Pittsburg	Division
22	1358–1379	10/16/34	Union Oil Dock, New York Slough	Division
2	1380–1381	10/16/34	Booth Cannery Dock, New York Slough	Division
71	*1382–1453	10/16/34	Big Break, Sherman Island	Division

* Tags 70, 326, 610, 661, 904 and 1407 lost.

TABLE I—Continued

Striped Bass. Tagged, 1932-1935

Number of bass tagged	Tag numbers	Date	Locality	Tagged by
35	1454-1488	10/17/34	Big Break, Sherman Island	Division
19	1489-1507	10/17/34	Off Sherman Island under Towers, Sacramento River	Division
2	1508-1509	10/17/34	Sacramento Pt., Point of Sherman Island, Sacramento River	Division
5	1510-1514	10/29/34	Big Break	Division
123	1515-1637	10/30/34	Off Chain Island near Collinsville	Division
3	1638-1640	10/31/34	Wheeler Island Club, Dock	Division
2	1641-1642	10/31/34	Dutens Cutoff, Snag Island	Division
2	1643-1644	10/22/35	Suisun Cutoff, near Rich Island	Division
5	1645-1649	10/23/35	Inside Slough, Suisun Fish and Game Refuge	Division
10	1650-1659	11/ 7/34	Between Beacon No. 1 and Towers, Napa River	Sportsmen
1	1660	11/14/34	Above Toll Road, Napa River	Sportsmen
1	1661	11/28/34	Above Sears Point, Toll Road, Napa River	Sportsmen
20	1662-1681	11/28/34	Above Toll Road, Napa River	Sportsmen
8	1682-1689	9/25/35	New Mare Island Causeway, Napa River	Sportsmen
1	1720	9/ 1/35	North Vallejo	Sportsmen
1	1721	9/ 8/35	Hill's Slough, Napa River	Sportsmen
20	1722-1741	9/ 9/35	Stanley's Wharf, Napa River	Sportsmen
2	1742-1743	9/22/35	Junction Hill and Suisun Slough, Napa River	Sportsmen
3	1744-1746	9/29/35	North Vallejo	Sportsmen
15	1747-1761	10/13/35	Towers, Napa River	Sportsmen
8	1762-1769	10/27/35	Towers, Napa River	Sportsmen
1	1770	11/17/35	Marrow Cove, Napa River	Sportsmen
1	1771	11/24/35	Beacon No. 2, Napa River	Sportsmen
1	1772	11/17/35	Marrow Cove, Napa River	Sportsmen
1	1773	11/24/35	Beacon No. 2, Napa River	Sportsmen
6	1774-1779	12/ 8/35	Basalt Landing, Napa River	Sportsmen
15	1780-1794	10/23/35	Inside Slough, Suisun Refuge	Division
2	1795-1796	10/24/35	Off the Dairy, Pittsburg	Division
3	1797-1799	10/24/35	Mouth, Spoon Bill Slough	Division

Total number tagged by Division of Fish and Game	944 striped bass
Total number tagged by sportsmen	600 striped bass
Grand total	1,544 striped bass

TABLE II

Record of Recovery—Striped Bass

Tag No.	Date tagged	Place tagged	Size when tagged	Date of recovery	Place of recovery	Time released		Distance covered	
						Mos.	Days	Direction	Miles
			Inches						
1	9/20/32	S. Hampton Bay, Carquinez Strait	12.0	11/23/32	Napa River above Sears Point	2	3	Down	13.5
4	9/20/32	S. Hampton Bay, Carquinez Strait	14.0	3/16/33	Above Antioch Bridge	5	27	Up	13
7	9/20/32	Middle Ground, Suisun Bay	12.5	10/ 8/32	Seal Island, Bay Point	......	18	Down	3
18	9/21/32	Middle Ground, Suisun Bay	15.0	12/15/32	Mouth New York Slough	1	22	Up	1.5
21	9/21/32	Middle Ground, Suisun Bay	10.0	9/25/32	Off Stake Point, Contra Costa County	......	4	Up	1.5
26	9/21/32	Middle Ground, Suisun Bay	15.5	2/15/33	Off Rodeo, San Pablo Bay	5	10	Down	14
28	9/21/32	Middle Ground, Suisun Bay	16.0	10/23/32	Between Bay Point and Pittsburg	1	2	Up	1
29	9/21/32	Middle Ground, Suisun Bay	16.0	10/ 2/32	Off Bay Point		11	......	2
31	9/21/32	Middle Ground, Suisun Bay	17.0	7/13/33	Sacramento River, Isleton		24	Up	21
49	9/21/32	Middle Ground, Suisun Bay	16.0	4/27/33	Off Pinole Point, San Pablo Bay	7	8	Down	18
52	10/27/32	1 mi. above R.R. bridge, Suisun Bay	14.0	1/ 2/33	Off Chipps Island Ferry	2	7	Up	11
61	10/27/32	Middle Ground, Suisun Bay	12.5	3/20/33	Three Mile Slough	4	24	Up	21
63	10/27/32	Middle Ground, Suisun Bay	14.0	11/10/32	Mouth of Mokelumne River	......	14	Up	26
66	10/27/32	Middle Ground, Suisun Bay	10.0	2/ 9/33	Off Collinsville, Sacramento River	4	4	Up	10
72	10/27/32	Middle Ground, Suisun Bay	17.0	4/ 5/33	San Pablo Bay	5	10	Down	18
76	10/27/32	Middle Ground, Suisun Bay	15.0	7/ 4/33	Off Tormey, Carquinez Strait	8	5	Down	8
87	10/27/32	Middle Ground, Suisun Bay	13.0	5/ 1/33	Mouth, Middle River-San Joaquin River	6	6	Up	9
89	10/27/32	Middle Ground, Suisun Bay	11.0	5/22/33	Steamboat Slough, Sacramento River	6	27	Up	24
93	10/27/32	Middle Ground, Suisun Bay	15.5	11/24/32	Near Canal Ranch, Mokelumne River	1	27	Up	30
98	10/27/32	Middle Ground, Suisun Bay	20.0	2/15/33	Off Rodeo, San Pablo Bay	4	4	Down	15
106	10/28/32	Off Snag Island, Suisun Bay	10.5	10/15/33	1 mile east of Antioch, San Joaquin River	11	24	Up	14
116	10/28/32	Middle Ground, Suisun Bay	10.5	9/22/33	Off McAvoy, Suisun Bay	10	29	Up	1
121	10/28/32	1 mile above R.R. bridge, Suisun Bay	10.5	3/15/33	Above Antioch Bridge	4	18	Up	15
135	10/28/32	Off Avon Wharf, Suisun Bay	13.0	3/24/33	Three Mile Slough	4	27	Up	25
139	10/28/32	Off Avon Wharf, Suisun Bay	10.5	4/26/33	Near Carquinez Bridge	6	0	Down	8
146	10/28/32	Off Avon Wharf, Suisun Bay	12.0	2/15/33	Off Rodeo, San Pablo Bay	4	3	Down	11
154	11/11/32	Mouth, Andy Mason Slough	10.5	1/10/33	Mouth Old River	2	0	Up	26
160	11/11/32	Mouth, Andy Mason Slough	11.0	3/ 5/33	End of New York Slough	3	24	Up	6
179	8/26/33	Antioch Bridge	10.0	10/15/33	Broad Slough	1	20	Down	4.5
181	11/24/32	Boynton Slough	41.0	12/ 1/32	Peytonia Slough	......	7	Up	3
186	9/28/33	Suisun Slough	16.0	11/12/33	Off Bird's Landing, Montezuma Slough	1	14	Up	10
*231	12/ 3/32	Between Ryer and Roe Islands	8.0	8/20/33	1 mile above Collinsville, Sacramento River	8	20	Up	12
236	12/ 3/32	Between Ryer and Roe Islands	9.0	9/22/33	Off Columbia Steel Docks, Pittsburg	9	22	Up	9
266	6/11/33	Steamboat Slough, Sacramento River	11.0	7/ 2/33	Head of Steamboat Slough	......	22	Up	6
272	11/11/32	Middle Ground, Suisun Bay	17.5	10/18/33	Off Bay Point, Suisun Bay	11	11	......	1
275	11/11/32	Broad Slough	10.0	3/17/33	Above Antioch Bridge	4	6	Up	5
294	8/19/33	Towers, Napa River	12.0	11/11/33	Upper end Snag Island, Suisun Bay	2	22	Up	22
300	8/19/33	Towers, Napa River	11.0	10/16/33	Middle Ground, Suisun Bay	1	28	Up	20

313	9/18/34	China Camp, San Pablo Bay	13.0	12/22/34	Off Nevada Dock, Martinez	3	4	Up	2-
320	10/25/34	Wingo, Napa River	16.5	11/10/34	Near Selby, Contra Costa County	------	15	Down	21
*323	11/13/34	Napa River	10.0	7/28/35	Fagan's Slough, Napa River	8	15	Up	4
325	11/13/34	Napa River	10.0	8/10/35	Beacon No. 2, Napa River	8	10	Up	1
339	10/25/34	Wingo, Napa River	10.0	9/12/35	Napa River	10	17	Down	12
341	12/29/34	Marin Island	25.0	2/15/35	Big Break, Sacramento River	1	16	Up	42
383	6/10/33	Ratto's Landing, Napa River	12.0	6/30/33	Off Rodeo, San Pablo Bay	------	23	Down	13
386	6/11/33	Ratto's Landing, Napa River	11.5	6/25/33	Beacon No. 2, Napa River	------	14	Down	9
396	7/29/33	Towers, Napa River	12.0	8/20/33	Toland Landing, Sacramento River	------	22	Up	34
*400	7/29/33	Towers, Napa River	8.0	10/11/33	Steamboat Slough, Sacramento River	2	14	Up	46
414	10/ 8/33	Beacon No. 2, Napa River	13.5	11/20/33	Black Can Buoy, Napa River	1	12	Down	2
451	10/17/33	Broad Slough	15.0	2/22/34	Broad Slough	4	5	------	0
454	10/17/33	Broad Slough	16.5	10/22/33	Pittsburg	------	5	Down	2
462	10/17/33	Broad Slough	17.0	2/22/34	Broad Slough	4	5	------	0
464	10/17/33	Broad Slough	16.5	11/ 8/33	Broad Slough	------	21	------	0
467	10/17/33	Broad Slough	11.5	2/22/34	Broad Slough	4	5	------	0
477	10/17/33	Broad Slough	7.0	11/ 2/33	Pittsburg	------	16	Down	2
*478	10/17/33	Broad Slough	9.0	11/25/33	Near McAvoy, Suisun Bay	1	8	Down	7
481	10/17/33	Broad Slough	8.5	11/ 4/33	¾ mile west of Antioch	------	17	Up	4
484	10/17/33	Broad Slough	9.5	2/16/34	Off Chipps Island R.R. Ferry, near Bay Point	3	29	Down	4
491	10/17/33	Broad Slough	16.5	3/29/34	Near Sycamore Park, Sacramento River	5	12	Up	15
515	10/18/33	Point of Chipps Island, Honker Bay	8.5	2/23/34	Honker Bay	4	5	------	0
542	10/18/33	Point of Chipps Island, Honker Bay	8.5	2/15/35	Honker Bay	15	27	------	0
559	10/19/33	Point of Chipps Island, Honker Bay	15.0	4/ 6/34	Between Avon Wharf and Associated Oil Sand Bar	5	17	Down	9
571	10/19/33	Point of Chipps Island, Honker Bay	9.5	11/ 7/33	Off Pittsburg	------	18	Up	7
575	10/17/33	Broad Slough	9.5	2/16/34	Chipps Island R.R. Ferry, near Bay Point	3	29	Down	5
578	10/19/33	Point of Chipps Island, Honker Bay	9.0	11/12/33	Off Bay Point, Suisun Bay	------	23	Down	2.5
582	10/19/33	Point of Chipps Island, Honker Bay	12.5	2/21/34	Off Army Point, Suisun Bay	4	2	Down	12
597	10/19/33	Point of Chipps Island, Honker Bay	9.0	3/12/34	Honker Bay	4	23	------	0
598	10/19/33	Point of Chipps Island, Honker Bay	10.0	11/13/33	Between Port Chicago and Pittsburg, Suisun Bay	------	24	Up	3
602	10/19/33	Point of Chipps Island, Honker Bay	8.5	2/15/35	Honker Bay	15	26	------	0
617	10/19/33	Broad Slough	17.0	3/ 7/34	Off Giant, San Pablo Bay	4	18	Down	32
618	10/19/33	Broad Slough	16.0	5/15/34	Near Pittsburg	0	26	Down	2
620	10/19/33	Broad Slough	17.0	11/12/33	Stake Point, near Pittsburg	------	23	Down	6
626	10/19/33	Broad Slough	14.0	11/15/33	Broad Slough	------	26	------	0
686	11/ 7/33	Off Browns Island, near Pittsburg	11.0	2/23/34	Honker Bay	2	16	Down	4
700	11/ 7/33	Off Browns Island, near Pittsburg	9.0	9/ 1/34	Big Break, 1 mile east of Antioch	9	9	Up	5
723	11/ 8/33	Grizzly Bay	9.5	2/19/34	Off Army Point, Suisun Bay	3	11	Down	11
724	11/ 8/33	Grizzly Bay	10.0	7/16/34	Off Granger Wharf, Martinez	8	8	Down	13
744	11/ 8/33	Grizzly Bay	9.5	2/19/34	Off Army Point, Suisun Bay	3	11	Down	11
752	11/ 8/33	Grizzly Bay	10.0	3/ 2/34	Near Collinsville, Sacramento River	3	24	Up	12
774	11/ 8/33	Grizzly Bay	12.0	3/12/34	Honker Bay	4	4	Up	6
783	11/ 8/33	Grizzly Bay	10.0	5/15/34	Off Pittsburg	6	7	Up	11
799	11/ 8/33	Grizzly Bay	11.0	2/16/34	Chipps Island R.R. Ferry, near Bay Point	3	8	Up	6
819	11/ 8/33	Grizzly Bay	9.0	3/30/34	Middle River, near town, San Joaquin River	4	22	Up	38
829	11/ 8/33	Grizzly Bay	9.5	3/12/34	Near Chipps Island, Suisun Bay	4	4	Up	6
838	11/ 8/33	Grizzly Bay	12.0	2/23/34	San Joaquin River at Three Mile Slough	3	15	Up	21
850	11/ 9/33	Grizzly Bay	13.5	1/13/34	Off Antioch	2	4	Up	12
858	11/ 9/33	Grizzly Bay	9.5	2/16/34	Chipps Island R.R. Ferry, near Bay Point	3	7	Up	6

* Fish recovered, tag recorded and fish liberated again.

TABLE II—Continued

Record of Recovery—Striped Bass

Tag No.	Date tagged	Place tagged	Size when tagged	Date of recovery	Place of recovery	Time released		Distance covered	
						Mos.	Days	Direction	Miles
			Inches						
871	11/ 9/33	Grizzly Bay	15.5	11/14/33	Mouth, San Joaquin River	......	5	Up	9
873	11/ 9/33	Grizzly Bay	17.5	5/ 1/34	Mouth Middle River-San Joaquin River	5	22	Up	30
876	11/ 9/33	Grizzly Bay	12.0	5/15/34	Off Pittsburg	6	6	Up	8
885	11/ 9/33	Grizzly Bay	17.0	2/ 9/34	Off Army Point, Suisun Bay	3	10	Down	11
924	4/ 1/34	San Joaquin River, Carbona District	10.0	6/15/34	San Joaquin City, San Joaquin River	2	15	Up	10
925	4/ 1/34	San Joaquin River, east of Tracy	10.0	4/16/34	San Joaquin River, 10 miles south of Tracy	......	16	Up	10
995	10/15/34	Broad Slough	10.0	10/27/34	New York Slough, near Pittsburg	......	12	Down	2
997	10/15/34	Broad Slough	11.0	2/17/35	Sacramento River, off Sherman Island	4	2	Up	3
998	10/15/34	Broad Slough	11.0	10/28/34	Middle Slough	......	13	Down	1
1003	8/17/34	Napa River, above Sears Toll Road	8.0	11/10/34	Benicia Wharf	2	27	Up	16
1009	8/17/34	Napa River, above Sears Toll Road	8.5	1/15/35	Broad Slough	5	2	Up	34
*1019	8/29/34	Napa River, between Barn and Towers	11.0	10/25/34	Napa River, 1 mile above Cutting's Wharf	1	26	Up	2
1041	8/21/34	Rio Vista, Sacramento River	13.5	9/14/34	Junction, Three Mile and Seven Mile sloughs, near Rio Vista	......	23	Down	3
1056	9/ 5/34	Between Beacon and Towers, Napa River	9.0	10/ 5/34	Mallard Slough near Pittsburg	1	......	Up	31
1057	9/ 5/34	Between Beacon and Towers, Napa River	9.0	9/29/34	Whites Point, Napa River	......	24	Up	3
1069	9/ 5/34	Between Beacon and Towers, Napa River	9.0	10/15/34	Vallejo, Napa River	1	10	Down	4
1091	9/22/34	Suisun Cutoff Slough	15.0	11/ 4/34	Point Buckler, Suisun Bay	1	12	......	0
1093	9/22/34	Suisun Cutoff Slough	15.5	10/ 7/34	Off Bay Point	......	15	Up	4.5
1129	9/22/34	Grizzly Bay	14.5	10/21/34	Oil Dock Rodeo, San Pablo Bay	1	2	Down	21
1172	9/12/34	Above Sears Toll Road, Napa River	9.0	10/ 7/34	Off Pittsburg	......	25	Up	32
1173	9/12/34	Above Sears Toll Road, Napa River	10.0	9/28/34	Napa River	......	16	Up	10
1190	9/26/34	Napa River	11.0	11/17/34	Napa River, Flemings Wharf	1	21	Up	6
1193	9/26/34	Napa River between Beacon and Towers	11.0	11/12/34	Napa River, above Beacon No. 1	1	16	......	0
1199	9/26/34	Napa River between Beacon and Towers	10.0	10/17/34	Off Benicia Wharf	......	21	Up	10
1202	9/19/34	Grizzly Bay	18.0	10/ 7/34	Mouth Suisun Slough, Suisun Bay	......	18	Down	7
1212	9/19/34	Point Buckler, Suisun Bay	15.0	10/20/34	Suisun Slough, near Cordelia Slough	1	1	Up	4
1225	9/17/34	Off Freman Island, Suisun Bay	15.0	11/11/34	Off Pittsburg	1	24	Up	6
1275	10/ 3/34	Big Break, above Antioch	11.0	2/20/35	Off Antioch	2	4	Down	2
1278	10/ 3/34	Big Break, above Antioch	10.0	12/ 7/34	Point Costa, Carquinez Strait	2	4	Down	22
1292	10/17/34	Napa River, above Sears Toll Road	10.0	10/22/34	Mare Island Lighthouse	1	5	Down	11
1296	11/ 7/34	Napa River between Beacon No. 1 and Towers	9.5	12/23/34	Napa River, ¼ mile above Beacon No. 1	1	16	......	0
1309	10/15/34	Big Break, Sacramento River	16.0	11/11/34	9 miles, below Rio Vista	......	26	Up	9
1312	10/15/34	Big Break, Sacramento River, Sherman Island	16.0	2/ 8/35	Carquinez Strait	3	23	Down	24
*1316	10/15/34	Big Break, Sacramento River, Sherman Island	11.5	4/27/35	Napa River	6	12	Down	27
1319	10/15/34	Big Break, Sacramento River, Sherman Island	10.0	3/ 5/35	Antioch Bridge	4	20	Down	3
1320	10/15/34	Big Break, Sacramento River, Sherman Island	11.0	6/ 2/35	Off Antioch	7	17	Down	3
1325	10/15/34	Big Break, Sacramento River, Sherman Island	10.0	8/ 8/35	Off Martinez	9	23	Down	21

1346	10/15/34	Big Break, Sacramento River, Sherman Island	12.0	6/16/35	Little Break, Sacramento River	8	1	------	0
1353	10/16/34	Middle Slough	14.0	10/28/34	Hasting Harbor, Suisun Bay	------	12	Down	8
1367	10/16/34	Union Oil Dock, Pittsburg	10.5	12/13/34	Off Benicia	1	27	Down	16
1387	10/16/34	Big Break, Sherman Island, Sacramento River	12.0	11/ 4/34	Broad Slough and Sacramento River	------	18	Down	4
1415	10/16/34	Big Break, Sherman Island, Sacramento River	12.0	11/ 6/34	North end Broad Slough	------	20	Down	4
1416	10/16/34	Big Break, Sherman Island, Sacramento River	9.5	6/16/35	Off McAvoy, Suisun Bay	8	------	Down	10
1456	10/17/34	Big Break, Sherman Island, Sacramento River	9.5	11/12/34	Off Brickyard, Port Costa, Carquinez Straits	------	25	Down	22
1465	10/17/34	Big Break, Sherman Island, Sacramento River	10.0	11/11/34	Breaks near Antioch	------	24	------	0
1487	10/17/34	Sacramento River, off Sherman Island	11.5	3/ 4/35	Antioch Bridge	4	17	Up	3
1492	10/17/34	Sacramento River, off Sherman Island	16.0	11/ 4/34	Inside Sherman Island	------	17	------	0
1493	10/17/34	Sacramento River, off Sherman Island	14.5	10/28/34	Broad Slough and Sacramento River	------	11	Down	2
*1498	10/17/34	Sacramento River, off Sherman Island	11.5	11/ 4/34	Near Rio Vista, Sacramento River	------	17	Up	12
1499	10/17/34	Sacramento River, off Sherman Island	13.5	11/16/34	1 mile south of Collinsville, Sacramento River	------	29	Down	3
1529	10/30/34	Chain Island, near Collinsville, Sacramento River	12.0	11/16/34	Off Collinsville, Sacramento River	------	16	------	0
1540	10/30/34	Chain Island, near Collinsville, Sacramento River	9.0	8/ 8/35	Steamboat Slough, 8 miles from Rio Vista	9	8	Up	18
1551	10/30/34	Chain Island, near Collinsville, Sacramento River	10.0	2/15/35	Honker Bay	3	15	Down	4
1579	10/30/34	Chain Island, near Collinsville, Sacramento River	11.5	7/ 3/35	Near Isleton, Sacramento River	8	3	Up	17
*1592	10/30/34	Chain Island, near Collinsville, Sacramento River	12.0	11/11/34	Sacramento River, near Collinsville	------	11	------	0
1598	10/30/34	Chain Island, near Collinsville, Sacramento River	16.0	9/27/35	Off McAvoy, Suisun Bay	10	27	Down	7
1608	10/30/34	Chain Island, near Collinsville, Sacramento River	11.0	10/26/35	Off Benicia	11	26	Down	18
1622	10/30/34	Chain Island, near Collinsville, Sacramento River	11.5	12/ 8/34	Glen Cove across from Crockett	1	8	Down	22
1625	10/30/34	Chain Island, near Collinsville, Sacramento River	16.5	11/ 6/34	Off Collinsville, Sacramento River	------	6	------	0
1650	11/ 7/34	Between Beacon No. 1 and Towers, Napa River	9.0	8/ 5/35	Off Port Chicago	8	28	Up	18
1653	11/ 7/34	Between Beacon No. 1 and Towers, Napa River	9.0	8/ 6/35	Off South Vallejo, Napa River	8	29	Down	5
1667	11/28/34	Above Sears Toll Road, Napa River	9.0	8/20/35	Honker Bay	8	22	Up	31
1724	9/ 1/35	Stanley's Wharf, Napa River	15.5	11/ 3/35	Lighthouse, mouth of Napa River	2	3	Down	11
1729	9/ 1/35	Stanley's Wharf, Napa River	8.0	9/29/35	2 miles north Cuttings Wharf, Napa River	------	28	Up	4

* Fish recovered, tag recorded and fish liberated again.

TABLE III

Tagging and Recovery Localities

No.	General localities	Number Striped Bass tagged, 1932-1935, incl.	Percentage of total tagged	Number recoveries of tagged Bass up to Jan. 1, 1936	Percentage of tagged Bass recovered for each locality	Number tagged Bass recovered in same locality as tagged	Percentage of all recoveries, taken in same locality as tagged	Number bass recovered in different localities than in tagged areas	Percentage of all recoveries taken in different localities	San Pablo, No. 1	Napa River, No. 2	Middle Ground, No. 3	Grizzly Bay, No. 4	Honker Bay, No. 5	Pittsburg, No. 6	Broad Slough, No. 7	Lower Sacramento River, No. 8	Upper Sacramento River, No. 9	Antioch, No. 10	Upper San Joaquin, No. 11	Elkhorn Slough, No. 12
1	San Pablo Bay and Carquinez Straits	42	2	4	10	0	0	4	3		1	1							2		
2	Napa River and vicinity	336	21	29	7	16	10	13	9	4		3		1	2	1		2			
3	Middle Ground, Suisun Bay and vicinity	196	13	28	15	6	4	22	15	7				1	3		3	3	2	3	
4	Grizzly Bay and vicinity	346	22	22	6	4	3	18	12	1		8		1	2		1		1	4	
5	Honker Bay and vicinity	134	9	12	9	5	3	7	5			4			2					1	
6	Pittsburg vicinity	60	4	4	7	0	0	4	3	1		1		1					1		
7	Broad Slough	82	5	19	23	5	3	14	9	1		3			6		1	1	2		
8	Lower Sacramento River vicinity	151	10	14	9	5	3	9	6	2		1		1		1		3	1		
9	Upper Sacramento River vicinity	11	1	2	18	2	1	0	0												
10	Antioch and Big Break vicinity	172	11	15	9	5	3	10	7	3	1	2				3		1			
11	Upper San Joaquin River vicinity	9	1	2	22	2	1	0	0												
12	Elkhorn Slough, Monterey County	2	x	0	0	0	0	0	0												
	Totals	1,544		151	10	50	33	101	67	19	2	23	0	5	15	5	5	10	9	8	0

TABLE IV

Sizes of Striped Bass. Tagged and Recovered, 1932-1935

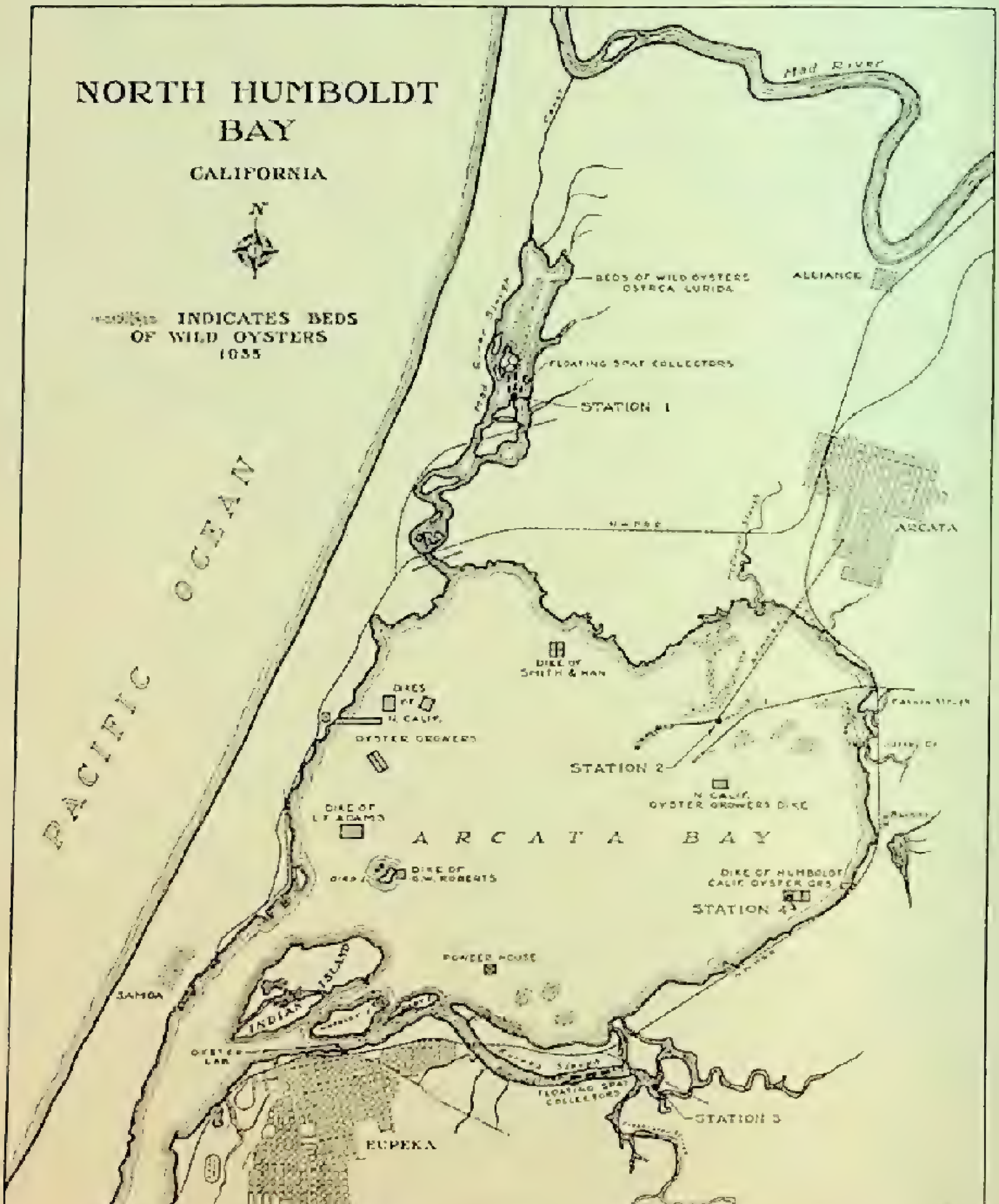
*Size in inches	Number of Striped Bass tagged at each size					Number Striped Bass recovered at each size when tagged—1932-1935
	1932	1933	1934	1935	Total	
5		1			1	
6		1			1	
7		10	2	1	13	1
8	2	56	53	9	120	9
9	19	111	115	30	275	22
10	42	106	177	37	362	26
11	38	63	145	16	262	23
12	27	45	66	12	150	16
13	9	10	38	7	64	7
14	6	15	43	3	67	8
15	18	27	23	3	71	12
16	15	28	17	2	62	13
17	8	14	12		34	8
18	4	1	6		11	1
19	8	2	7	1	18	2
20	1	4	9		14	1
21			1	2	3	
22	1		2	2	5	
23		1		1	2	
24			1	1	2	
25			1		1	1
26			1		1	
27			1		1	
28			1		1	
29						
30						
31		1	1		2	
41	1				1	1
Totals	199	496	722	127	1,544	151

* All bass tagged were measured to the nearest ½ inch, but for simplicity the ½ inch measurements have been grouped with the inches in this table.

REPORT OF THE OYSTER INVESTIGATION AT HUMBOLDT BAY FOR 1935

By PAUL BONNOT

With the renewal of interest in California oyster growing several years ago, a number of companies were formed to promote that industry in Humboldt Bay. A survey of the bay was made and it was decided



to confine operations to the growing of native oysters (*Ostrea lurida*), as the importation of exotic species opens the way for the introduction of oyster pests from which the bay was altogether free. Several natural beds of native oysters were found available as brood stock. There still seems to be some misapprehension as to the origin of these oysters. A great many people still think they are the results of several transplants from Olympia which were made about thirty years ago. As witnessed by the thick shell deposits underlying the bay, the native oysters have grown there naturally for many thousands of years. (Fig. 67.)

At the end of the first season the growers found they had made two major mistakes. The available quantity of oysters of breeding age had been considerably overestimated; the natural beds were extensively tonged and the oysters so obtained replanted in various parts of the bay where no natural beds existed. As natural conditions in most of the areas selected for replanting were not favorable for spawning and setting, from a standpoint of reproduction, the majority of the transplants were therefore lost. Some of these transplanted oysters were subsequently taken up again and sold, but as they were wild stock and therefore not uniform in size or shape the price received was small, and they created an unfavorable impression on the trade which is used to oysters of definite size and shape. Selling wild oysters is a questionable business at best.

For those unfamiliar with the spawning, setting, and manner of collecting the young oysters it might be well, at this point, to explain somewhat. The native oyster is hermaphroditic. Each individual produces both sperm and eggs which become mature at different times, so that the sperm of one oyster fertilizes the eggs of another. The eggs are not thrown into the water but are retained in the mantle cavity where they are fertilized by the sperm brought to them in the current of water which the oyster causes to continually flow through its gills. The unfertilized eggs and the first stages of development are called white spawn as they are of that color. As development proceeds the spawn changes in color from white to a dark grey, which is called black spawn. The individual larvae are never in exactly the same stage of development, some reaching the trochophore, or free swimming stage, earlier than others. (Fig. 68.) The trochophores are able to take care of themselves and leave the mantle cavity of the adult in the outgoing water current. A single oyster may produce many thousand larvae, maturing, and allowing them to escape into the water over a period of several weeks. As some individuals spawn before others there is a continuous throwing out of larvae from May until September. Swimming about in the water, the larval oyster continues to grow until a definite size is attained and a tiny shell has been developed. If conditions are not satisfactory for setting, the young oysters continue their free swimming existence and when the time comes there are generally vast numbers ready to set. Although some may be several weeks older than others, the stage of development in all of them is approximately the same. The young oysters set by securely fastening the left valve of the shell to any clean hard surface. They lose their power to move about and remain permanently in the same position unless subsequently moved by some outside force. Setting occurs in one or more waves during the season. The waves of setting are evidently determined by

an optimum combination of environmental factors. The amount of swimming spat in the water is by no means indicative of the number which will set. Our knowledge of this phenomenon is far from complete.

To catch the spat many kinds of collectors have been utilized and several methods have been developed. The method in general use along the Pacific coast at the present time consists of dipping paper egg crate fillers into a soupy mixture of sand and cement. When dry the collectors are stiff and brittle. The fillers are either laid out on a hard bottom or, if in deep water, are placed in slatted redwood crates and suspended from logs or floats. For best results the collectors should be put in at the beginning of a wave of setting. If put in too early they become loaded with silt and overgrown by other organisms before the oyster spat are ready to use them. A knowledge of the approximate date of setting is therefore important.

FIG. 68. The trochophore stage of the native oyster (*Ostrea lurida*). When they tire of swimming they settle down and draw in the swimming organ as has the one in the center. Photomicrograph by Paul Bonnot.

Until the present season no detailed data of the environmental conditions for Humboldt Bay were available. Because of this lack, the growers have put their collectors in by guess, based on the experience of oyster growers in other sections of the country. As the conditions vary in nearly every bay, this method has obvious faults.

At the start of the 1935 season, the first effort to collect detailed data was begun at Humboldt Bay by the California Division of Fish and Game. (Fig. 69.) Humboldt County, as an interested party, supplied a laboratory situated on the water front in Eureka. The Division authorized an assistant and Warren Dunaway of Los Angeles acted in that capacity during the summer. Detailed data were collected from the first part of May until the first of October. Although the data accumulated during one season are not sufficient as bases upon which to draw definite conclusions, they do show what happened in that

season. With another season's work for comparisons some pertinent questions may be satisfactorily answered.

With no previous data available and with a desire to determine the setting times with some accuracy, biweekly samples were taken. Only two small waves of setting occurred but both of them were noted within a day or two of their beginning. The first, a very small wave, came down during the early part of July. The second began during the latter part of July and lasted until the middle of August. Knowing the lack of data and having been fairly successful with their own methods of handling the collectors for several years, the growers, with one exception, put in their collectors on the fourth of July. Very little spat was caught and by the time the second wave of setting

FIG. 69. The Oyster Laboratory at Eureka. Bags of Shells piled at the side. Photo by Paul Bonnot.

materialized the collectors were thoroughly coated with mud. They were lifted and washed at the first showing of the second wave, but as the water tends to soften them and they carried a considerable weight of mud, a good many collapsed during the process and had to be discarded. One company held most of their collectors and began putting them in about the middle of July. Although a trifle early, this seems to have been the proper procedure as these collectors caught a much heavier set than any of the others. In all 120,000 collectors were used on the bay during the season. (Fig. 70.)

A great deal of painstaking work has already been done with oysters and some of the methods of collecting the basic data have been in use for a long time. There is nothing original, therefore, in most of the methods detailed here except as local adaptions were necessary.

Four stations in widely separated parts of the bay were used as data collecting points. (Fig. 67.) Station 1 was a collecting float anchored over the natural bed in the upper reaches of Mad River Slough. Station 2 was the Arcata wharf at the convergence of several channels containing natural oyster beds. Station 3 was at a short railroad bridge in proximity to the natural beds in Eureka Slough, and Station 4 was in a dike of the Humboldt California Oyster Growers. These stations were visited twice a week. At Station 2 the growers made no attempt to catch spat. At Stations 1 and 3 the collectors were hung from floats and at Station 4 they were laid on the bottom.

To determine the time and intensity of the spat fall, wire bags filled with shells were used. The bags were made of one-inch galvanized chicken wire, cut and sewed with wire in the form of a cylinder three feet long. They contained approximately a bushel of dried Japanese oyster shells. Each bag was numbered with a metal tag.

FIG. 70. Two barge loads of spat collectors ready to be towed out and planted.

They remained in the water for a week and were put out and taken up so that they were staggered as to time. On Monday a bag was put out and another on Thursday. The following Monday the first bag was picked up and replaced with a new one, and so on. At Stations 1 and 3 two sets of bags were kept in operation; one near the surface and the other on the bottom. It was necessary therefore to examine six bags of shells twice a week. The bags were assumed to contain 150 shells although most of them ran slightly over that number. The shells were taken from the bags in lots of 25 and gone over with a binocular at 30X. If no spat were found on the first 50 shells the bag was considered blank. If, however, a single spat was found, the remaining 100 shells were examined. In counting the spat, only the inside, smooth surface of the shell was used. The outside surface is very rough and dark in color which makes counting extremely difficult. It has been

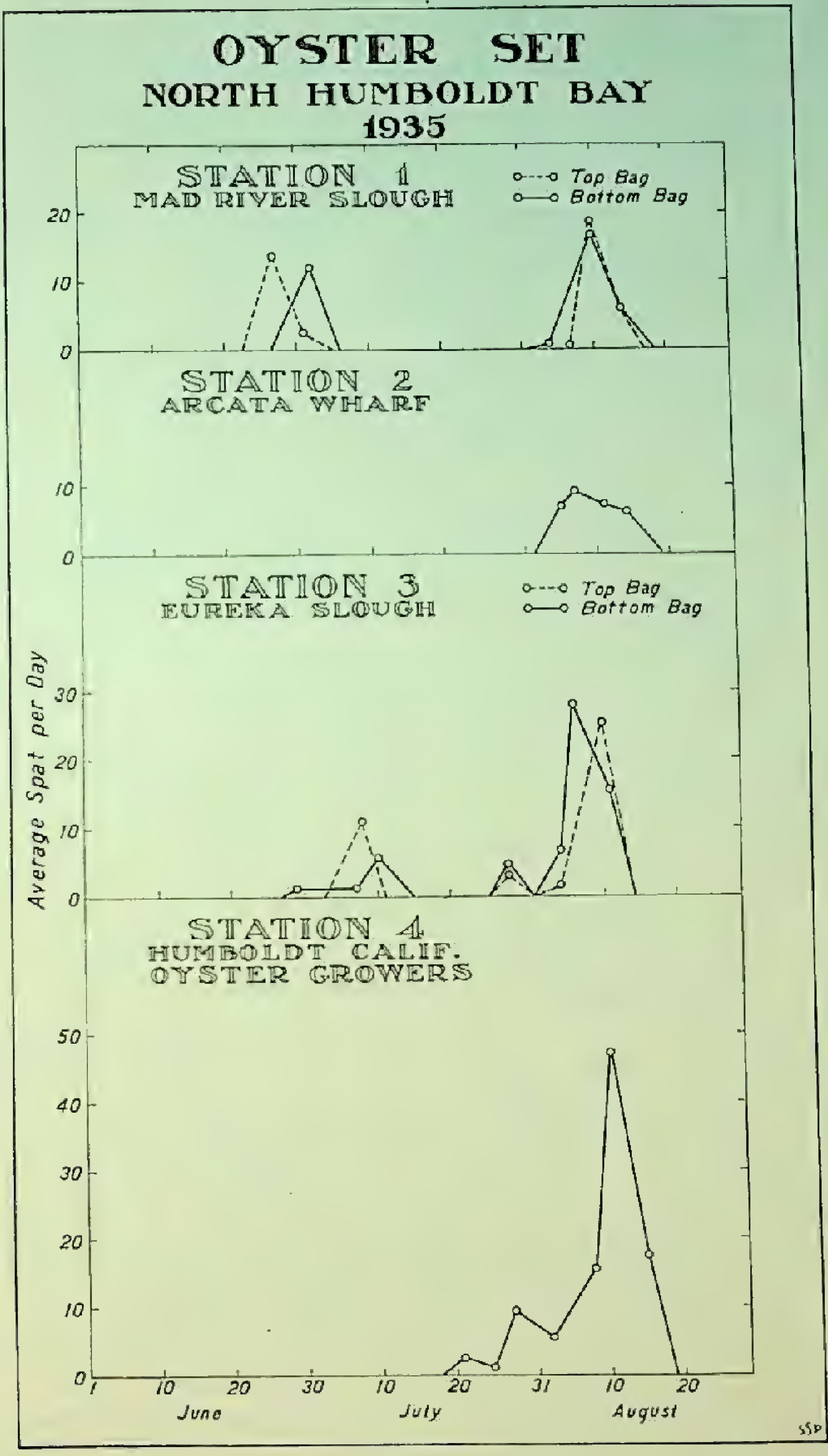

OYSTER SET
NORTH HUMBOLDT BAY
1935
STATION 1
MAD RIVER SLOUGH
Top Bag
Bottom Bag
STATION 2
ARCATA WHARF
STATION 3
EUREKA SLOUGH
Top Bag
Bottom Bag
STATION 4
HUMBOLDT CALIF.
OYSTER GROWERS
Average Spat per Day
0
10
20
30
40
50
1
10
20
30
10
20
31
10
20
June
July
August

FIG. 71.

found (Hopkins, unpublished report) that the number of spat on the smooth, inside surface is 35 per cent of the total number to be found on the shell. The addition of the 65 per cent to the actual number counted

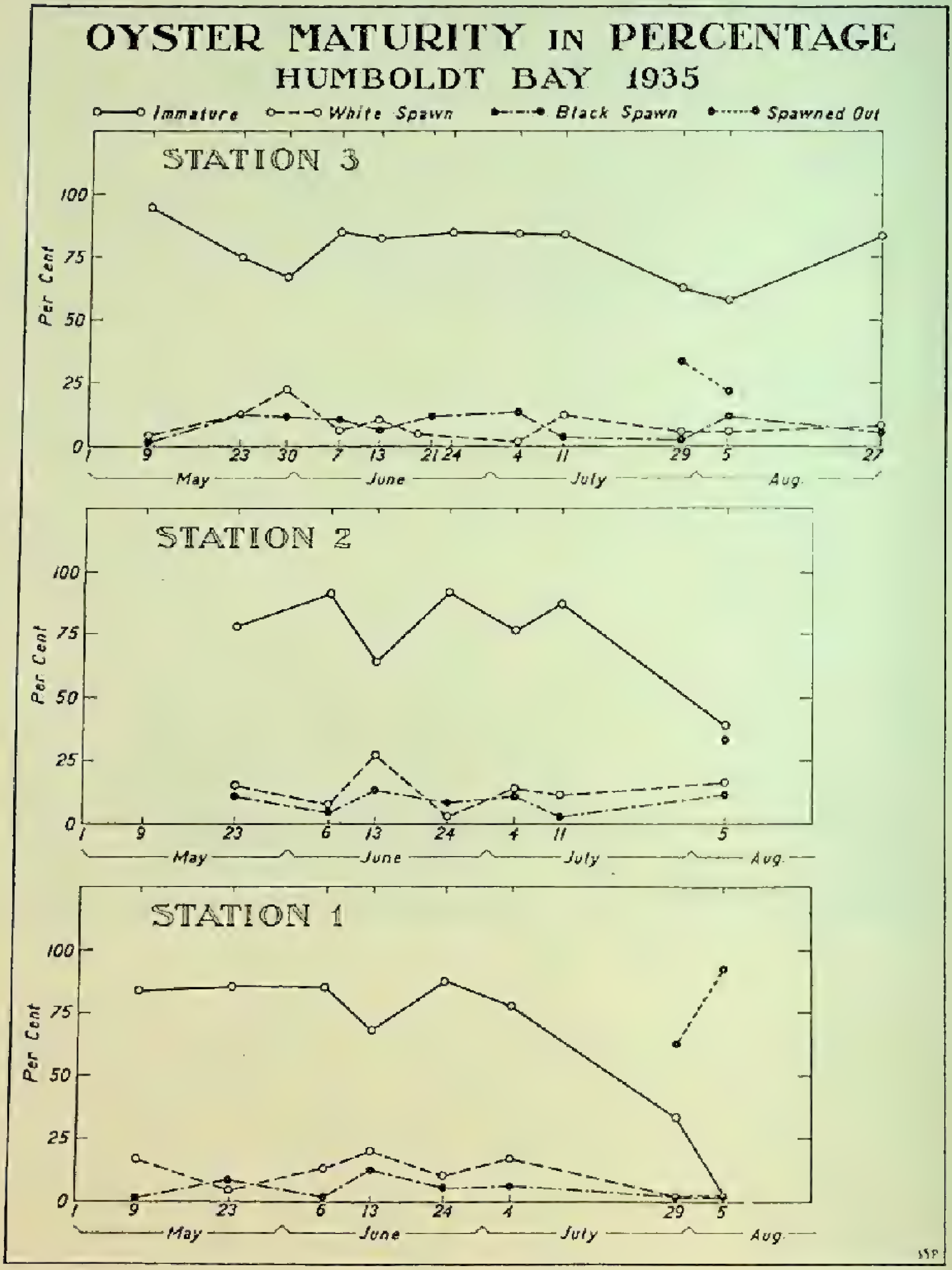


FIG. 72.

therefore gave the total number for the bag. As each bag was in the water a week the total number was divided by 7 for a daily average and the figure so obtained, used as a point on the graph (Fig. 71).

Once a week a sample of approximately 100 oysters was tonged from Stations 1, 2 and 3, opened in the laboratory, and the condition of the gonads noted. These oysters fall roughly into four groups—immature, white spawn, black spawn, and spawned out. The maturity ratios of the samples from Stations 1 and 2 show a consistant relationship as was to be expected. As the number of immature indiviuals decreases, a proportional increase of the ones that are spawned out occurs. The Station 3 samples show no such relationship. Why this is so, is not apparent at present. (Fig. 72.)

A water sample was taken at each change of bags and tested for salinity and *p*H. The salinity was measured by delicate specific gravity hydrometers and reduced to parts per M. Station 1 shows little fresh water present. (Fig. 73.) Station 2 has a slight amount of fresh water derived probably from Jacoby Creek. Station 3 shows a considerable amount of fresh water which comes from Freshwater Creek. The *p*H content of these samples shows little variation, ranging from 7.6 to 8.6 which can be considered normal. Hopkins has found that if a wave of setting starts during a run of neap tides, the peak of the curve will generally occur at or shortly after the following run of spring tides. The two waves of setting recorded this season in Humboldt Bay fall readily into place with the tide curve.

Station 4 caught a heavier set than any other locality in the bay. The fact that the station was located in a dike may have had some influence, although the greatest factor was no doubt the fact that the collectors were put in the water just before the July-August set. The eastern side of the bay seems more favorable for setting in any case. On this side of the bay are several natural oyster beds with the requisite amount of fresh water from Jacoby and Freshwater creeks. Oysters seem to set better where there is a slight amount of fresh water, but after they have once set the salinity appears to have no effect on their rate of growth. The floating collectors at Station 3 caught a fair set but many of them were lost when the floats went adrift during a November storm. The set at Station 1 was practically a failure. The growers claim a set of 300 per collector from Stations 3 and 4, but it will probably be found that they will average between 150 and 200. As 200 per collector is considered a commercial set the companies that realized that number and saved them have not done so badly, but all things considered, the set should be, in a good year many times greater.

The methods being used at the present time for catching and growing oysters are rapidly increasing the total population of oysters in the bay. Some seasons are more favorable for spat catching than others, but with an increase of brood stock and a more exact knowledge of handling the collectors, the number of spat taken in a good year should more than balance several lean years. With the accumulation of more data and the knowledge derived therefrom, it should not be difficult to time and even to predict the waves of setting before they occur.

At the present time there are three companies at work in the bay. They are building bottom and otherwise extending their operations. Although originally planned as a native oyster industry, by unanimous agreement the growers brought in 130 barrels of eastern seed oysters during November of this year (1935) and planted the major

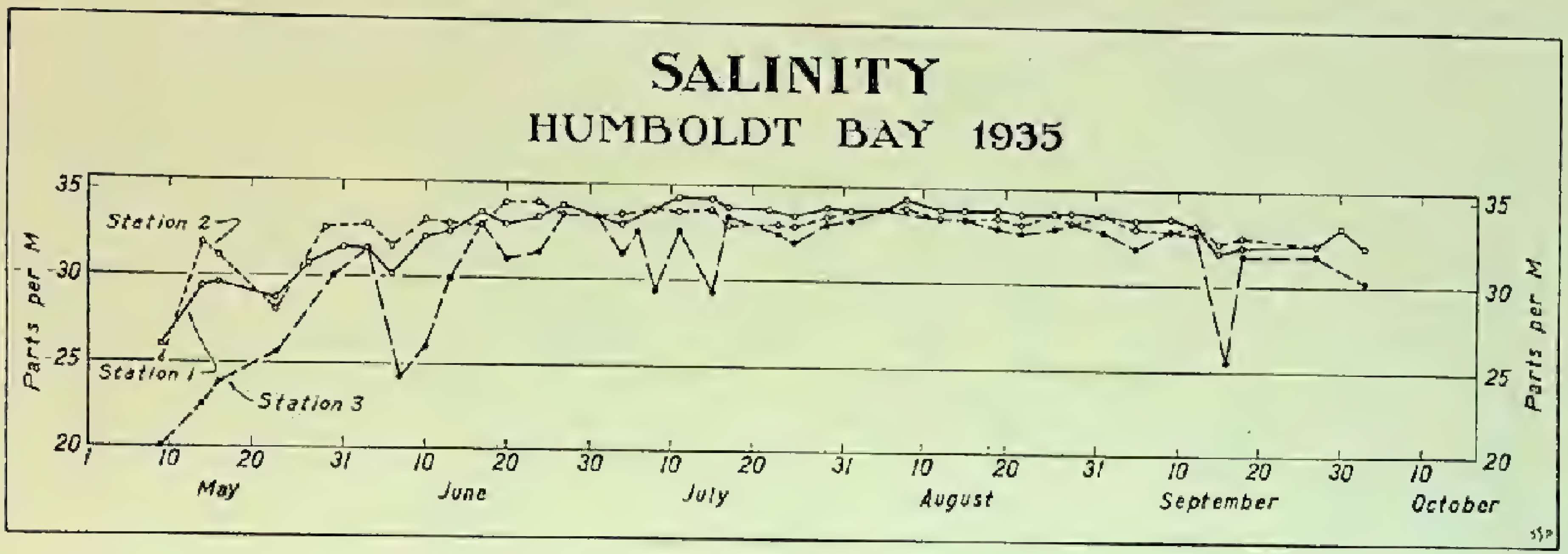

SALINITY
HUMBOLDT BAY 1935
Station 2
Station 1
Station 3
Parts per M
35
30
25
20
1
10
20
31
May
June
July
August
September
October

FIG. 73.

portion of them on two beds in north bay. A few barrels were also planted in south bay. These will be marketable before the natives can be brought to the point of quantity production and will therefore aid the growers to finance their efforts until that time. The seed was inspected on arrival and although there were no drills present quite a few slipper shells (*Crepidula fornicata*) were found.

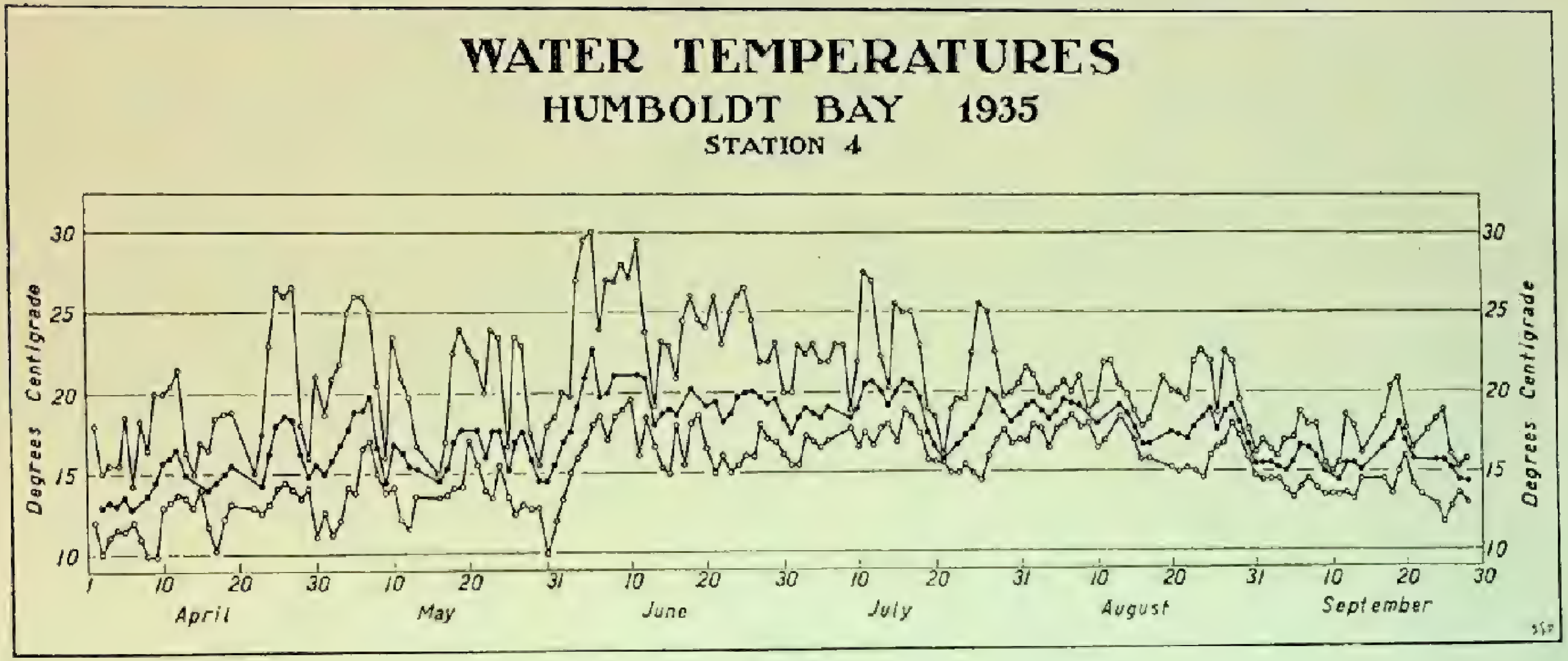

WATER TEMPERATURES
HUMBOLDT BAY 1935
STATION 4
Degrees Centigrade
30
25
20
15
10
1
10
20
30
31
April
May
June
July
August
September

FIG. 74.

SIXTH ANNUAL BLACK BRANT CENSUS IN CALIFORNIA

By JAMES MOFFITT

The sixth consecutive annual count of black brant (*Branta bernicla nigricans*) on California bays frequented by the species was made in 1936 on the usual days, February 9–12. Prior censuses have been reported upon in the October numbers of CALIFORNIA FISH AND GAME following them. In most cases the same observers have made the counts on the respective areas either for several years or for all six, thus assuring comparative uniformity in methods. This year some changes in personnel, mentioned later in the reports for individual areas, were made necessary; but in every instance the new observer had assisted in at least one previous census in the same locality and had thus learned the methods employed. It is not felt that these changes in cooperators have in and way influenced the comparative value of the counts.

Acknowledgment is hereby made, with sincere thanks, for the assistance rendered by the cooperators named under the area reports which follow:

HUMBOLDT BAY

Game Warden W. F. Kaliher, who assisted in the 1935 census on Humboldt Bay, made the 1936 count. He counted on South Humboldt Bay from motor boat the morning of February 9, a calm, sunny day. The result was 41,000 brant. In the afternoon, working from shore with 12 power binoculars, he counted 8000 brant on North Humboldt Bay. February 10 was sunny in the morning, but with light cloudiness which increased during the day until rain commenced to fall at 5 p.m. This day Kaliher used the motor boat on North Bay in the morning, making one trip around and two across the Bay. Results indicated that 9000 brant were present. Observations with glasses later that day from the shore of South Bay confirmed the previous day's count of 41,000 birds. Quoting from Kaliher's report: "there seemed to be about the same number as the day before which was about 41,000."

Tides on Humboldt Bay (South Jetty) were as follows:

February 9, 1936—Low tide, 7.13 a.m., 1.9 ft.; high tide, 12.57 p.m., 5.8 ft.; low tide, 7.30 p.m., 0.4 ft.

February 10, 1936—Low tide, 7.54 a.m.. 1.7 ft.; high tide, 1.39 p.m., 5.5 ft.; low tide, 8.01 p.m., 0.8 ft.

This census indicates a total of approximately 50,000 black brant present on Humboldt Bay, February 10, 1936.

BODEGA BAY

Dr. J. M. Linsdale, University of California Museum of Vertebrate Zoology, who has taken annual censuses of brant on Bodega Bay since the first one was made in 1932, again covered the locality this year. His report follows:

"I arrived at Bodega Bay at 9.30 a.m. on February 10 and stayed there until nearly noon. Although the wind was strong in the southwest, the water on the Bay was fairly quiet. The light was not good because of clouds, but there was no rain.

"The brant were scattered at first. Later they congregated into several small groups. The total was smaller than any other count that I have made. I could get only about 350. Possibly as many as 500 per present. Many were scattered among the ducks and coots and hard to tally accurately."

Tides on Bodega Bay, February 10, 1936, were as follows:

Low tide, 6.41 a.m., 1.8 ft.; high tide, 12.52 p.m., 4.8 ft.

TOMALES BAY

For the sixth consecutive year the writer counted the brant on Tomales Bay, using an outboard motor boat and following customs previously established. The count was made between 8.40 and 11.30 a.m., February 10, 1936. Tides were approximately the same as above noted for Bodega Bay and the weather was similar to that reported by Dr. Linsdale. The fresh southwest wind did not interfere with traversing the Bay in the usual manner, but exceptional concentration of the brant mixed in an enormous flock with scoters and cormorants in the center of the Bay opposite Hamlet, made accurate counting difficult. By finally driving most of the brant to flight a fairly satisfactory count was secured. The total was 9175 brandt, 8836 of which were located on that part of Tomales Bay lying between Hog Island and Tom's Point. Along the eastern shore south of Hamlet 234 brant were noted and only 105 birds were counted on the "Outer Bay" between Tom's Point and the ocean. This distribution of brant on the Bay is unusual for this season, for in previous years the birds have been found rather generally scattered over the whole area north of Cypress Grove to the ocean. Unquestionably tidal conditions and a spawning of herring in the large eel grass flat in the Bay opposite Hamlet afforded optimum feeding conditions which accounted for the brant concentration there (see map, CALIFORNIA FISH AND GAME, **18**, 1932, p. 301).

DRAKE'S BAY

J. E. Cushing, Jr., who assisted in the 1934 count at this point, took the 1936 census at Drake's Bay the morning of February 10, coincident with the Bodega and Tomales Bay censuses. Tidal and weather conditions on Drake's Bay were similar to those already noted for Bodega Bay. Cushing counted with difficulty, on account of shifting back and forth of brant on the bay, 1367 black brant by actual count. He considered this figure an underestimate of the entire population and submitted 1500 birds as a conservative total for the brant present that day. Cushing used the same methods of counting as were employed by T. T. McCabe who made the previous four counts on this Bay.

MORRO BAY

Dr. A. P. Marshall, San Luis Obispo, who lives on the shores of Morro Bay, counted 5000 brant on its waters from a motor boat on

February 9, 1936. This was intended as a preliminary census to the regular one which was scheduled for February 12, the date upon which the 1935 count was made. Game Warden F. W. Hecker was to have assisted Dr. Marshall in the work. Heavy storms, commencing February 11 and continuing almost steadily for two weeks thereafter, made conditions on Morro Bay unsuitable for accurate census work. On February 20, Hecker and Dr. Marshall attempted to count the brant in the Bay from the shore, but found it impossible to procure an exact enumeration, however, they felt that their estimate of 6000 birds was a reasonably accurate one. Again on March 15, Dr. Marshall, assisted by his wife, counted the brant on Morro Bay. This was a clear, calm day and the birds were quiet so the total of 7100 counted was considered conservative and accurate.

For the purpose of this report, in order to keep the Morro Bay counts seasonably comparable, Dr. Marshall's census of 5000 brant present on February 9 is used. Previous counts in this area were made February 10 and 12.

Tides on Morro Bay, February 9, 1936, were:

Low tide, 5.32 a.m., 1.3 ft.; high tide, 12.19 p.m., 4.5 ft.

MISSION AND SAN DIEGO BAYS

L. M. Huey, San Diego Natural History Museum, who took the first three annual censuses on these bays, made the 1936 counts on February 12. In the morning of this day Huey counted 30 brant on Mission Bay where but 8 birds were present in the afternoon, the rest having evidently gone out to sea. Huey failed to find a single brant on San Diego Bay this day, although he covered its surface very thoroughly with binoculars. He attributed the absence of brant on this bay to exceptional activity of airplanes over it.

Tides for the day on San Diego Bay were:

Low tide, 6 a.m., 1.5 ft.; high tide, 11.39 a.m., 3.9 ft.; low tide, 5.23 p.m., 1.4 ft.

TABLE I

Recapitulation of the California Black Brant Census, 1931-1936

Locality	1931	1932	1933	1934	1935	1936
Humboldt Bay	Unsatisfactory	29,415	5,000	16,860	115,000	50,000
Bodega Bay	None made	3,200	977	1,298	3,700	350
Tomales Bay	9,445	6,285	7,409	5,565	6,850	9,175
Drakes Bay	None made	2,108	318	2,189	1,995	1,500
Morro Bay	4,403	2,038	None made	3,895	7,544	5,000
Mission Bay	71	No birds	115	154	9	30
San Diego Bay	No birds	No birds	No birds	7	55	No birds
Totals	Incomplete	43,846	13,819	29,968	135,153	66,055

An interesting check upon our brant census work in the Bodega, Tomales and Drake's bay section was afforded by independent counts made by game wardens February 9 and 10.

Game Warden V. E. von Arx's report for the census on Bodega Bay follows:

"On February 9, 1936, Deputy Groves and myself arrived at Bodega Bay at 8. a.m. We counted the brant on the Bay, and found

about 750. It was a clear, cool morning with a medium tide and very smooth water.

"On February 10, 1936, Deputy Groves and I arrived at Bodega Bay at 7 a.m. We again counted the brant, and found about 300 birds. The weather was very cloudy, and very cool—raining a little, at times, with a southerly wind blowing. This count was made on a medium low tide.

"It is a little too early for brant on Bodega Bay. We always have the most brant in March and April on Bodega Bay."

Note how closely the game warden's figure of 300 brant present on Bodega Bay February 10, 1936, tallies with Dr. Linsdale's count of 350. The fact that the game wardens counted 750 brant in the same area on the previous day indicates how the birds' numbers may fluctuate from day to day. It is probable that the brant unaccounted for on February 10 were either on the ocean or on Tomales Bay. We have long recognized the fact that the local brant population in this vicinity fluctuates between Bodega and Tomales bays, which is the reason we now count the birds in this area at the same time (see CALIFORNIA FISH AND GAME, 19, 1933, p. 257).

Game Warden Bert Laws reported results of his brant counts on Tomales and Drake's bays as follows:

Tomales Bay

"February 9th—Time: 10. a.m. Wind: light, south. Slightly cloudy. Tide: flooding, about 2 hours past low water. I used a 33 power telescope in making these estimates.

"About 6000 birds were rafted on a weed patch below Hog Island and opposite White's Gulch. Another 1000 were off Tom's Point. About 500 were scattered, making a total of seven or eight thousand in the bay.

"February 10th—Time: 10 a.m. Wind: fresh, south. Cloudy. Tide: flooding about an hour.

"The brant were feeding in the same places as the day before and about the same number. However, about 4000 were below the Island and about 3000 off Tom's Point. I met James Moffitt who said there were more brant in the bay than at this time last year.

Drake's Bay (Estero)

"February 9th—Time: 2 p.m. Wind: light, south. Light clouds. Tide: high water. Accompanied by Captain Lencioni. Count was taken from vicinity Bull Point on the Gallagher Ranch.

"Birds were all feeding along the south shore, about 2000 in all.

"February 10th—Time: 3 p.m. Wind: fresh, south. Cloudy, showers. Tide: high. Birds were scattered and restless making them hard to count. However, there seemed to be about the same number as the day before about 2000."

Game Warden Laws' estimate of brant on Tomales Bay February 10 falls about 1500 birds short of my count. This discrepancy is not surprising in view of the difficulty I had in separating the brant from the cormorants and scoters with which they were feeding, when

relatively close to them in a boat. Indeed it is remarkable and gratifying to me that the game warden was able to make so accurate a count from shore with glasses, a mile or more distant from the birds.

In the case of Drake's Bay, the game warden's total of 2000 brant present February 10 may be more nearly correct than Cushing's figure of 1500, for the latter is very conservative, but I am accepting Cushing's count for the census.

I was particularly actuated to publish the results of the game warden's counts in comparison with our regular census cooperators' figures to demonstrate how reliable the former are. The results indicate that these game wardens are able to make rather accurate bird censuses, without special training. I believe that this information will be of interest to some people who have, in the past, expressed little confidence in bird counts made by game wardens.

BRANT ARRIVALS ON CALIFORNIA BAYS FALL OF 1935

Game Warden Hecker reported that brant arrived at Morro Bay earlier in 1935 than in the previous season. He states that at least 1500 brant were on the Bay on the opening day of the shooting season, November 20, 1935, whereas very few birds were present a year previous. Hecker advised that the brant appeared to remain about constant in this number on Morro Bay until early in January when they increased to about 4500 birds. After that the numbers fluctuated greatly from day to day; sometimes there would be only 2000 brant present, then, in a few days, this number would increase to four, six or eight thousand birds.

This information indicates to me that about 1500 black brant stopped their southward migration in the fall at Morro Bay, where they wintered. Numerical increase in the birds at this point early in January is attributed to the peculiar mid-winter northward movement of the species from Lower California, more fully discussed by me in several of the preceding brant census reports. That the numbers of brant in Morro Bay fluctuated greatly after this migration commenced, indicates that the birds merely stopped here for a short while, and then continued northward along the coast.

On Tomales Bay, I made no observations in the fall of 1935 until December 7 when I estimated that there were approximately 3000 brant present. Four days later there seemed to be still more birds in evidence. I did not again visit the region until the census was taken on February 10. Upon a later trip, March 18, I covered the Bay quite thoroughly by boat and estimated that 8000 brant were present, a smaller number than was recorded in the census. Major Allan Brooks accompanied me on this trip and positively identified five or six individuals of the eastern or light-bellied brant (*Branta bernicla hrota*), the first of this sub-species, so far as I am aware, to be recorded from the Bay, although I have looked for them there for years. These birds were standing on a gravel spit on Hog Island and stood apart, in a separate group, from a hundred or more black brant similarly located, thus the eastern birds were most conspicuous. Major Brooks is very familiar with both forms which he has shot in British Columbia and

where the eastern one seems to be much more numerous than with us, so there can be no doubt about this record.

Practically no brant were killed by hunters on Tomales Bay during the 1935 shooting season as the Federal regulation prohibited shooting farther than 100 feet from shore at high tide mark precluded chances to bag these wary birds.

Captain of Game Wardens W. J. Harp, in a letter dated January 29, 1936, advised that up to that time few brant had appeared on Humboldt Bay. There must have been a heavy influx of the birds into this region shortly thereafter for Warden Kaliher found 50,000 present on February 10. This condition is similar to the migration at the same point a year previous when Harp advised that the large concentration of brant did not reach Humboldt Bay many days before February 11 (see CALIFORNIA FISH AND GAME, 21, 1935, p. 344). It is of interest to note that the thousands of black brant which arrived at Humboldt Bay during the first ten days of February, came during a period of fair weather. They are thought to have arrived from the south. The two weeks of heavy storms, with continued rainfall over 14 consecutive days in this area, did not commence until just after the census was completed at Humboldt Bay on February 10, 1936.

SUMMARY

The 1936 census indicated that fewer brant were present in California on the appointed dates than in the previous year. The greatest discrepancy existed at Humboldt Bay, but it was caused by the unusually heavy concentration found there in 1935. Fifty thousand brant were counted at this point in 1936, far more than were observed at the same place in 1932, 1933 or 1934, so this year's figure is relatively high notwithstanding that it is less than half of the 1935 estimate.

Numbers of brant on the other California bays seem, judging from previous counts, to remain fairly constant. The 1936 aggregate for all census points save Humboldt Bay is approximately 4000 birds less than the 1935 count, however it is greater than any of the earlier censuses. This fact tends to indicate that our Pacific Coast brant are in a satisfactory condition and are probably increasing in numbers. Very few brant were shot by gunners in California in the 1935 hunting season due to severely restrictive Federal regulations governing waterfowl shooting.—*California Academy of Sciences, San Francisco, Calif.*

PREVENTION OF FISH LOSS IN WATER DIVERSIONS [1]

By John Spencer

In the development of an area or a country and the utilization of the natural resources for the benefit and enjoyment of the people, problems are created which, if not intelligently solved and appropriate remedial measures applied, may result in the decrease or destruction of other natural resources. It is generally accepted that the encroaching civilization has an adverse effect upon the wild life, and instances are not uncommon where a species has decreased in numbers or entirely disappeared. Adjustment between the demands of development and the needs of fish and game are required in order that a reasonable degree of use and enjoyment may be had by the people, of this, a natural resource. The waters of the streams and lakes have been diverted for irrigation, hydroelectric, and industrial uses without regard for the adverse effect on fish life.

Subsequent to the initial diversion of water in the Western United States, which occurred about 88 years ago, there has been a rapid development of the country and there is no question but that these irrigation diversions and later hydroelectric uses made this great growth possible. This has, however, left stream beds dry, or nearly so, and otherwise changed the character of the streams and lakes to such an extent that fish life has suffered. Dams have been built which have stopped the upstream movement of fish to their spawning grounds, the limited water left in the streams has been subjected to pollution which has contributed to limiting the range and food for fish, and only in rare instances has any effort been expended to prevent fish from entering the diversions and proceeding to their ultimate destruction.

In general, irrigation diversions of water more readily furnish proof of loss of fish than diversions for other uses. During the irrigation season food and game fish may be seen on the irrigated lands, at drops in the canal system and in the smaller laterals and depressions. When the water is shut off at the headgates the fish usually are left stranded at these points. Occasionally nets have been placed in irrigation canals in order that information might be obtained as to kinds and movements of fish; and where this has been done the evidence, in general, was that fish were in the canals and proceeding downstream. The diversions from some streams take all the water and naturally the fish follow the flow of water and hence, in time, are lost. There are many diversions of this kind. Water taken from a lake or reservoir also adversely affects fish life.

Further evidence may be had by comparing the abundance of fish life in the streams and lakes prior to these developments with that existing at the present time. Some of the streams are entirely devoid of fish life; and, in many, the numbers are extremely limited. Loss of fish through unprotected diversions can and generally does occur whenever water is taken by gravity or by mechanical means from a

[1] Published by permission of the U. S. Commissioner of Fisheries.

water course, lake, or reservoir, which is the habitat of fish. This generally applies regardless of the locality. This loss of fish through water diversions has apparently been recognized by a number of states as laws have been enacted providing for remedial measures.

Losses of fish due to pollution and obstructions in streams are generally visible to the public. It appears that governmental agencies receive more support in applying remedial measures to these two factors than they do when efforts are put forth to prevent loss of fish in the water diversions where such losses are not as apparent and only a very limited number of the public are aware of the great loss which is continually taking place. Even when known many are of the opinion that no reasonable remedy may be applied. A commonly accepted solution of the problem appears to be increased planting of fish, and governmental agencies have been and are constantly urged to add to the hatchery equipment and much has been done along this line. Improved and scientific hatchery methods have been employed, and the output has been materially increased; but this aid to natural propagation will fail in repopulating the streams with fish unless protection is offered at these water diversions.

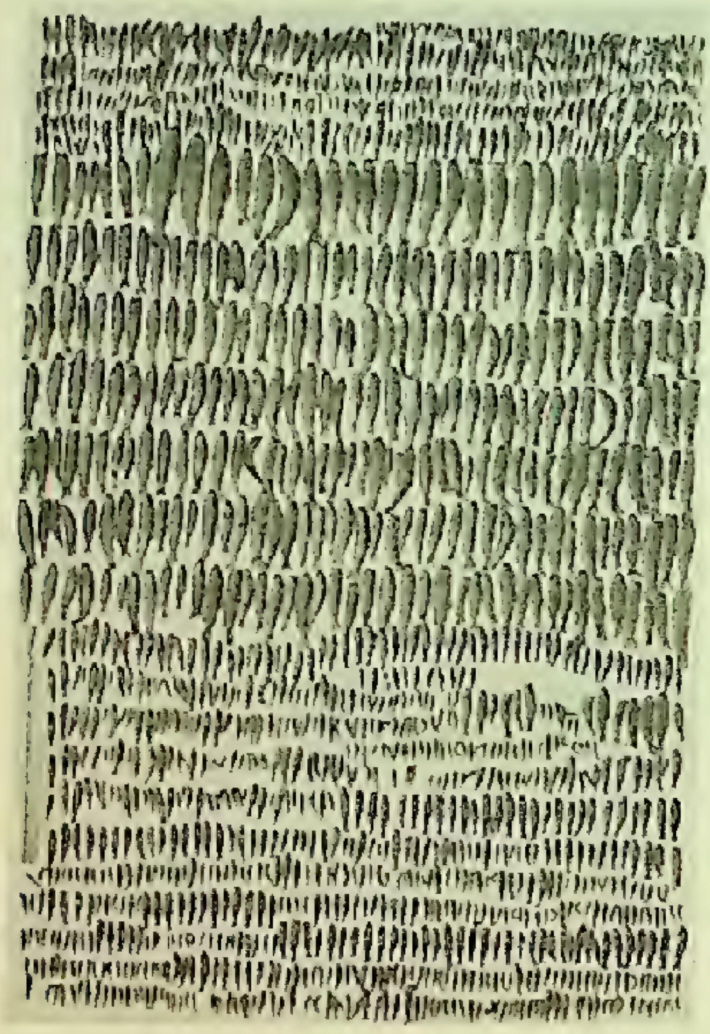


FIG. 75. The 1470 young steelheads shown above were found after draining a mile-long irrigation ditch in the Klamath River region.

This constant loss of fish through water diversions may be prevented by properly designed and constructed fish protection devices, commonly known as fish screens. A fish screen is a barrier installed at or near the entrance of a water diversion to stop fish from proceeding down the diversion and yet does not interrupt or interfere with the flow of the diverted water or its use.

Observations indicate, without doubt, that fish protection at these diversions has received little of intelligent thought and constructive effort. The water diverter has not included in his construction program any safeguards for fish; and even at this date, when the necessity for fish protection is so evident, new hydraulic developments and diversions are being contemplated which do not provide any protection for fish except in very rare instances. The water diverter has evaded the issue, stating that fish preservation was not his responsibility and ignoring the fact that he created the problem. Other objections have also been made; a common one being that fish screens stopped or interfered with

the flow of water with consequent loss to the irrigator or hindrance to other water uses.

The diverter has made these objections to fish screens and has failed to install them. There has been no apparent attempt to assist in designing a reasonably efficient screen. The general practice followed (covered by law in some states) is that the governmental agency shall provide the plans for fish screen installations. While objection might be made to this method as it, in a way, relieves the diverter of an obligation which must be assumed by the governmental agency, the writer is of the opinion that better installations may be obtained than if each diverter furnished his own design.

Governmental agencies have usually shown a willingness to assist and provide plans for screen installations. It is most unfortunate, however, that too many of the designs and plans furnished indicate a lack of understanding of the necessities of the diverter or of the operating conditions involved, and at times knowledge of fish and what formed a barrier to their downstream movement was also lacking. The installations as made, and based on these inadequate plans, were unsatisfactory, as too often the flow of water was obstructed, and where the diverted waters are so much a part of the life of the people, such stoppage or interference can not be countenanced.

As the screens installed failed to meet the needs of the water diverter they were removed and the general viewpoint became prevalent that all fish screens would also fail and that fish loss must of necessity be accepted. The greater damage accruing from these failures was the opinion that no reasonable fish protection device might be included in these diversions. Probably selfish diverters encouraged this belief as an aid to the avoidance of their responsibility.

In the areas where water is diverted there can be no question of the necessity of the inclusion of fish screen installations in a balanced conservation program. The responsibility for loss of fish and lack of proper fish protection at the diversions must be shared by the diverter and the governmental agencies, but the general apathy of the public and sportsmen or conservation bodies may not be overlooked. There is urgent need for educational and cooperative effort in meeting this vital problem.

When some new water diversion is being contemplated a complete and detailed study is made of all the factors involved, and the plans finally prepared are supposed to be the best for the particular diversion. A fish screen becomes a part of the diversion structure and hence each proposed screen installation requires similar study and inspection in order that all pertinent facts of the diversion be considered and the resulting fish screen plan should meet the particular needs of that diversion and be an efficient fish stop. Each installation is an individual one as will be shown in more detail later and, if any success is to be obtained in screen installations, must be so considered. Fish screens should be designed to meet certain conditions, and care should be exercised that a particular plan is not used indiscriminately. One or two types may become standard for a section, but no one screen will be acceptable for all diversions. The writer is convinced that one charged with the responsibility of design and installation of fish screens

should of necessity be fully informed and have practical experience of irrigation and hydroelectric system operations. Knowledge of fish habits is also required but, in so far as it applies to screen installations, is of secondary importance.

When fish protection is being considered for a particular diversion it should first be definitely determined if it is necessary. If a stream, lake or reservoir has its waters or portions of it diverted into a ditch, canal or penstock and fish are known to inhabit these waters, it may be reasonably expected that fish will enter the diversion. There may be certain periods when there is little, if any, movement of fish, but such periods of time are so limited that it will have no appreciable bearing. The expressed views of some people that fish tend to stay in the main stream, that they resist or stay away from suction pipes and penstocks, will not enter a tunnel, and remarks of a similar nature, all purporting to show that fish protection is not required, is not confirmed by observation and experiments. As fish have no way of knowing that they are entering a diversion which will result in their destruction, the diversion that does not require fish protection is rather exceptional.

To obtain the greatest efficiency in a fish screen installation at a minimum cost it would be necessary to have the fish screen plans and specifications included in the original plan covering the proposed construction of the diversion. This procedure would require the cooperation of the water diverter and governmental agency interested in fish protection. Unfortunately, the diversions, for the most part, have been made without inclusion of fish protection and hence any protection installed will be on diversions that have been in use for some time. With these conditions obtaining, it can not be expected that maximum efficiency will be obtained and proposed fish screen installations on the diversions in use will be balanced and adjusted to existing conditions.

The inspection and study of the diversion will give data on stream flows and relation to the diversion; size and amount of drift and debris carried by the stream; amount and kind of debris that will come in contact with the screen; water use period and fluctuations; maximum and minimum flows, velocity and depth of water; a cross section of the diversion at point of the proposed location of the protection; and extremes of climatic conditions. Detailed inquiry should also be made as to operating conditions and practices.

With the foregoing in mind, thought is given to the type of fish protection to be installed and its location so that the installation will function most satisfactorily. A location to be preferred, considered solely from a fish safety viewpoint, would be in front of the headgates of the diversion, as then fish could not leave the stream. The character of the stream, kinds of debris carried, relative position of the diversion headworks and the stream, depth of water and foundation difficulties, and available area for the structure are some of the factors which will determine the advisability of fish protection in this location. It may be that these factors will be so adverse that the consequent cost would not be justified if a location is available where construction costs will be materially less, though this latter location may not result in as an efficient installation. If there is a possibility that fish might be injured in passing through a diversion intake or that injuries might be sustained in the diversion itself, it is evident that fish protection must necessarily be located ahead of any such points.

If the protection may not be placed in front of the diversion a location as near the head as possible is desirable. There should be sufficient area so that the section may be widened if required. For the average diversion this factor of additional width is of no appreciable import, but with large flows of water the available area may be limited. Where the section is enlarged the upstream and downstream ends of the structure should be connected with the regular section of the diversion by suitable transitions. The upstream transition will equalize the flow of water over the entire section and in front of the screens, and the downstream transition will aid in the return of the water to the normal section. The velocity of the water immediately in front of the screen should be low so that fish will not be held against the screen but will be able to move at will.

In areas where the water supply of the diversion will permit of its installation and use, it is very desirable to install a by-pass from in front of the screen structure to the natural water course or stream which generally is adjacent to the diversion banks. This by-pass may be of any suitable material. Concrete pipe is permanent and can easily be installed. It is placed on grade with the bottom of the diversion and through the bank. The flow of water through this by-pass permits fish stopped by the screen to return to the stream. In areas where the water supply is limited the operation of a by-pass may not be possible. If this condition exists and anadromous fish are to be safeguarded, a different screen and location will probably be required.

In selecting the type or kind of fish screen that will more nearly meet the requirements of a diversion all known data, as well as possible future changes, are to be considered. In addition to the required data previously noted, information should be obtained as to the kinds of fish in the stream, migrating habits, if any, size at about the time they might arrive at the screen, and possible reaction to the barrier in their downward journey. If some of the fish have well developed migratory instincts, such as salmon, steelhead, and shad, it may be that a more effective barrier will be required than if fish without this strong trait are being considered. Turbidity of the water may also have a bearing. It may not be definitely stated as a fact but limited observation would indicate the need of a lower velocity of water at a screen if the water is turbid than if visibility in the water is good or nearly so.

After fish screens are installed they receive very little attention and care and hence their design should provide a minimum cost, simple and rugged structures with few moving parts, and be free from possible interference or stoppage due to the debris carried by the water. With more thought being given to the necessity of fish protection and with an understanding of the water diverter's conditions and necessities further developments will, without doubt, occur in fish screen design. Application of present knowledge, however, seems to be the immediate necessity.

Considerable interest and effort have been expended over a period of years to prevent fish from entering diversions by the use of electricity. At the point fish were to be stopped or diverted a charged electric zone was created which was supposed to be a barrier to fish movement. A number of experimental installations of this electric fish stop or screen have been made, and some interesting data have

been obtained; but it appears that, as yet, this type may not be accepted as an effective fish stop.

The parallel bar and the rotary screens are the two most common mechanical types in use. The former consists of parallel bars, generally of steel, spaced the proper distance apart so that fish may not pass between the bars and, if possible, so placed that minimum collection of debris will occur. The rotary type consists of a cylindrical drum framework covered with a wire mesh; the unit being placed in a diversion as a barrier to fish and rotating with or counter to the direction of water flow; power being furnished through the wheel itself or by an auxiliary unit. There are many adaptations of these two general types.

The parallel bar type of fish protection or screen is usually placed in front of the diversion works, at entrances to underwater surface and surface outlets from reservoirs or lakes, in front of penstock entrances, around suction pipe inlets of pumps, and in diversion canals. The simplest form of this type of fish protection is stationary and hence the debris carried by the water will accumulate on the bars and must be removed. The frequency of debris removal may be lessened by increasing the area enclosed or covered by the parallel bars. Increasing the area is especially advisable when the protection is under the water surface and is not accessible or only occasionally. Fish protection installed under the water surface and not accessible to cleaning, even though considered ample in area, may have included mechanical arrangements for removing any accumulated or adhering debris. If this mechanism is not kept in operation it should be checked periodically so that it will not fail to function when and if needed.

Bar types of protection are generally of flat steel, spaced one-half inch or less apart, though spacing is dependent on the size of fish to be stopped. The front face should be free from projections so no interference will be encountered when cleaning. In using the ordinary or rectangular steel bars it is found that small pieces of debris will start through the spaces and then, because of the irregularities, the debris will become lodged between the bars. The removal of this lodged material may be tedious. To obviate this condition the use of a deformed bar is suggested. For ordinary purposes a bar $\frac{3}{8}'' \times 1'' \times \frac{3}{16}''$ may be used, the front face being the $\frac{3}{8}''$ dimension. Any material passing the smallest space between the bars will not lodge but will be carried through by the flow of the water. This is a stock steel bar and its cost is only slightly in excess of the regular rectangular steel shape.

Rotary screens, briefly, consist of a steel shaft supporting a cylindrical framework which is covered with a wire mesh. This unit is then placed in a structure which has been constructed in the diversion with journals to receive the shaft. When the screen is in place no space is large enough for fish to pass through and all the water passes through the unit. Motive power to turn the screen is furnished by the screen itself or by a water power wheel which is usually set downstream from the screen.

The structure in the diversion should be so built that there will be no settling as it is esential that the shaft run true. Concrete construction is to be preferred, though in certain sections the cost may be lessened by the use of lumber. Care should be taken with the foundation. Permanent supports for the journals are necessary and cut off

walls are included and other measures taken to prevent leakage of water around the structure. The shaft size should be ample to carry the load of screen and in addition provide for considerable overload. Give in the shaft is to be avoided. Speed of the screen is low. After a screen is placed in operation it receives very little attention and sometimes much abuse. It should be simple in construction, sturdily built, and foolproof.

The framework or supports for the mesh may be of wood or steel. Wood is less expensive due to its low original cost and ease of placing and if well oiled and retouched occasionally will last for a number of years. Steel as material for the framework is much to be preferred and if properly designed and installed will, with very little attention, probably continue in operation for a lifetime.

In the design of fish screens there should be an effort to reduce interference with the flow of water to the minimum. Ample strength is

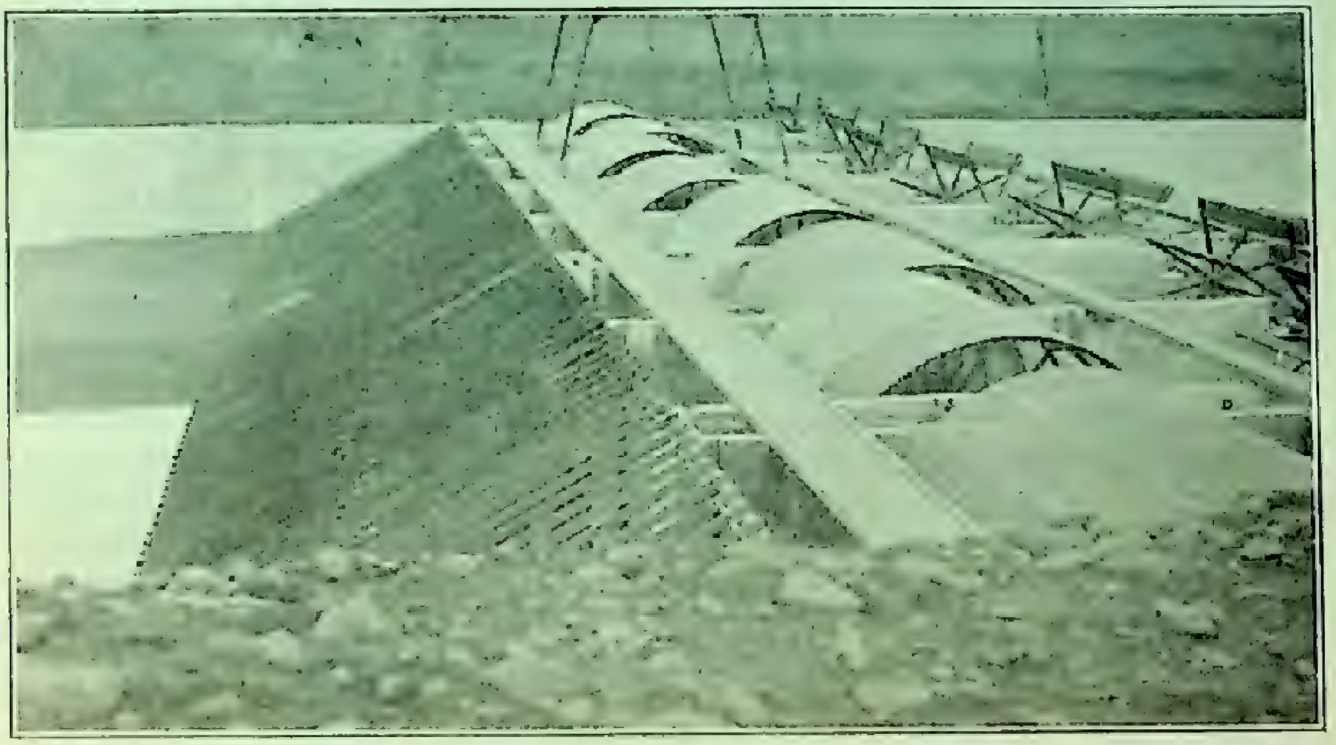


FIG. 76. Sunnyside Canal Screen near Yakima, Wash. Front and top view of rotary fish screens in canal of 1320 second-feet capacity. Eight screens each ten feet wide, ten feet diameter, and each operated by a water power wheel. When canal is operating to capacity, water is one foot below top of concrete.

required but the framework should be so arranged that the minimum of surface interferes with the water flow. Heavier or more supporting framework and lighter wire for mesh may be used or the reverse. The size and kind of debris that will come in contact with the screen will largely determine framework and mesh design.

One type of rotary screen in use in the Pacific Northwest States is most often spoken of as the Oregon screen. Practically the same screen in another section is named the Requa. The main difference between the two screens is the method of transmitting power from the water wheel to the screen. The U. S. Bureau of Fisheries has installed several of the Oregon type screens on federally owned diversions. A general description of the smallest installation will give an idea of this type.

The canal headgates of the diversion were a part of the diversion dam and at right angles to the flow of the river. The three headgates had under water surface openings and with average water level above the crest of the dam the velocity through the gates was such that fish would be unable to return to the river after having passed into the canal. A suitable screen site was found about 300 feet from the headgates, this site having a uniform water flow and being high enough above the river bed so that a good grade was obtained for the by-pass.

The canal section was widened and a reinforced concrete structure to receive two 10 feet wide screens was constructed, thus 20 feet of width of canal was screened. Each screen was of steel 4½ feet in diameter and 10 feet wide. The wire mesh used was a special weave and crimped, the long wires No. 10 gauge and spaced ⅜ inch (clear), the short or cross wires were two wires set close together and No. 12 gauge, the open space being 4 inches between cross wires, thus making the spaces in the mesh ⅜ inch by 4 inches. As the loom could not weave a piece 10 feet wide it was woven in two pieces and welded, the weld falling on a circular angle support. This type of mesh and gauge adds to strength and rigidity. Spacing may be changed as to size as conditions dictate. The journals are set to keep the bottom of the screen about six inches from the floor. This open space is closed by a piece of flat rubber placed on an adjustable frame so that contact of the edge of the rubber with the screen may be adjusted. The screen is raised from the floor, thus minimizing possibility of damage due to submerged material which otherwise might lodge against the screen, and the rubber, which is parallel to the shaft, in addition to closing the space cleans the wire mesh of any adhering material. Moss is plentiful and if not removed would soon close all spaces. The floor of the structure is below the canal grade and equal to the height of the seal, from a point in front of the screen to a few feet downstream from the outside diameter of the screen; thus the seal does not lessen the capacity of the canal. Downstream from each screen is a water power wheel of steel and connected with a drive chain. The power wheel rotates with the direction of the flow of water, the screen moving in a counter direction, thus carrying the debris over and it finally being carried downstream with the flow of the water. Slots are provided in the concrete walls in front and back of the screen and below the power unit so that water may be regulated or checked as desired. Immediately in front of the screen next to the river bank and from the bottom of the canal a concrete pipe is laid to the bottom of the river. This is the by-pass, by means of which the fish return to the river. In front of the screens and for the width of the canal is placed a trash rack on a flat slope to prevent heavy debris from damaging the screens. This fish screen is functioning satisfactorily and practically the only attention it receives is the removal of heavy debris from the trash rack. This drift would undoubtedly require removal at some point in the canal even if fish screens were not in place.

A rotary fish screen in use in California is similar to the Oregon screen but without its power wheel and driving mechanism. The screen has paddle boards set parallel to the shaft and at the circumference of the wheel, which causes the screen to rotate with the current of water. Debris is carried under the wheel instead of over, as in the Oregon screen. No other power is used and generally no

by-pass is installed. The screen is placed in the holding structure so that the lowest point in the screen is four to ten inches above the floor. The open space thus made is protected by a fine grizzly of bars or round iron welded to a transverse member which is set on the floor and parallel to the shaft of the screen. This transverse member moves on hinges and is held in place by springs or counterweights. When debris lodges against this grizzly the pressure is increased causing it to trip and lie parallel to the flow of water until the debris is washed away and then the grizzly returns to its normal position. The objection to this type of screen would appear to be that when the grizzly is down or open fish would pass through. It has been found in practice that very few fish do pass when the screens are properly constructed and installed. If material adheres to the screen a rubber scraper may be attached above the water line, similar to the seal used in the Oregon screen. In this type of screen it is necessary that all debris shall be stopped by a trash rack except as it may be less in dimensions than the distance between the bottom of the screen and the floor at point of location of movable grizzly. The screen as above described is easily constructed and operation and maintenance costs are at a minimum and it is reasonably efficient. It would not be suitable for diversions which carry a large amount of debris.

Certain manufacturers of construction and conveying machinery equip power, manufacturing, and filtration plants and water works with traveling water screens. These are for the purpose of removing suspended matter from the water so that condensers, pumps, filters, etc., will not become clogged. These screens or similar ones are also used in manufacturing processes. The writer does not know of any installation of traveling screens primarily for fish protection, but if installed for that purpose there is no question of the efficiency. Some of these screens have been in operation for 40 years.

In general, however, it is believed that fish protection may be had at most diversions at probably less cost than that of a marketed traveling screen, though they are of interest in showing what may be done when the necessity is sufficient and the success of these installations would appear to refute the statements made by diverters that it is impossible to install fish screens without interfering with the water supply.

THE CONSTRUCTION OF THE PURSE SEINE AS USED IN THE SAN PEDRO SARDINE FISHERY, 1935–1936 SEASON [1]

By RICHARD B. TIBBY

The purse seine net was first used in California during the earliest days of the sardine fishery (Scofield, 1926) but was later discarded in favor of the lampara, a net imported to this coast in 1905 from the Mediterranean. After a period of several years the purse seine was reintroduced in a very much altered form and its use, together with the lampara, has continued until the present time. A third type of net, known as the "ring net" (Fry, 1930), has been developed in the meantime. This ring net is a cross between a purse seine and a lampara and may exhibit all gradations between the two.

There are several adequate accounts of the methods of using purse seines (Phillips, 1930; Scofield, 1929; Whitehead, 1931) and one detailed description of their construction (Skogsberg, 1925). Since the publication of the latter paper, however, there have been several minor changes in the construction of purse seines, of sufficient importance to justify their being placed on record. The nets used at the present time differ widely in some unimportant respects, but the principle upon which they are built remains the same throughout.

The purse seine net is made like a long shallow curtain with a bag at one end. The top edge is floated by a series of corks (the cork line) and the bottom edge is weighted with a number of leads (the lead line). Also along the bottom are attached at intervals a series of rings through which a heavy line called the "purse line" is passed. When a school of fish is located the net is paid out over the stern of the boat, making a wide closed circle around the school. The ends of the net are made fast to the boat and the net is "pursed," that is, the purse line is drawn up until all the rings are bunched. These rings are then lifted aboard, and in this manner the bottom of the net is completely closed. One end of the net, the wing, is brought in and piled on the turntable in the stern of the boat. Thus the fish are concentrated in the small bag from which they are brailed and put into the hold.

The main body of the net is composed of two parts, the bag at one end, and the wing comprising the rest. In a typical net, 200 fathoms long and 30 fathoms deep, the bag is 25 fathoms long and the wing 175 fathoms. Nets vary, however, all the way from 150 to 300 fathoms, with the average around 195 fathoms. The depth is more constant, being seldom less than 30 or more than 40 fathoms. The length of the bag varies somewhat in different nets and ranges all the way from 20 to 40 fathoms. The bag and wing are both constructed of 1½-inch mesh cotton netting (stretched measurement[2]), but in tanned nets the bag is made of 12-thread line and the wing of 9-thread. Tarred nets

[1] Contribution No. 154 from the California State Fisheries Laboratory, April, 1936.

[2] All measurements of mesh size are given in stretched measurement, *i.e.*, the distance between the knots at opposite ends of any one mesh when the netting is stretched diagonally so that the meshes are completely closed.

sometimes use heavier line in the wing or in both bag and wing. The entire net may be made of 12-thread line or occasionally the bag and wing may be of 15- and 12-thread line, respectively. This netting is purchased in long strips, 400 meshes deep. The net is built by sewing together these horizontal pieces, as many as needed to make the net as deep as desired. A certain amount of shrinkage takes place when new netting is tarred or tanned and repeatedly immersed in salt water, so that the mesh size in a used net is actually about 1¼ inches.

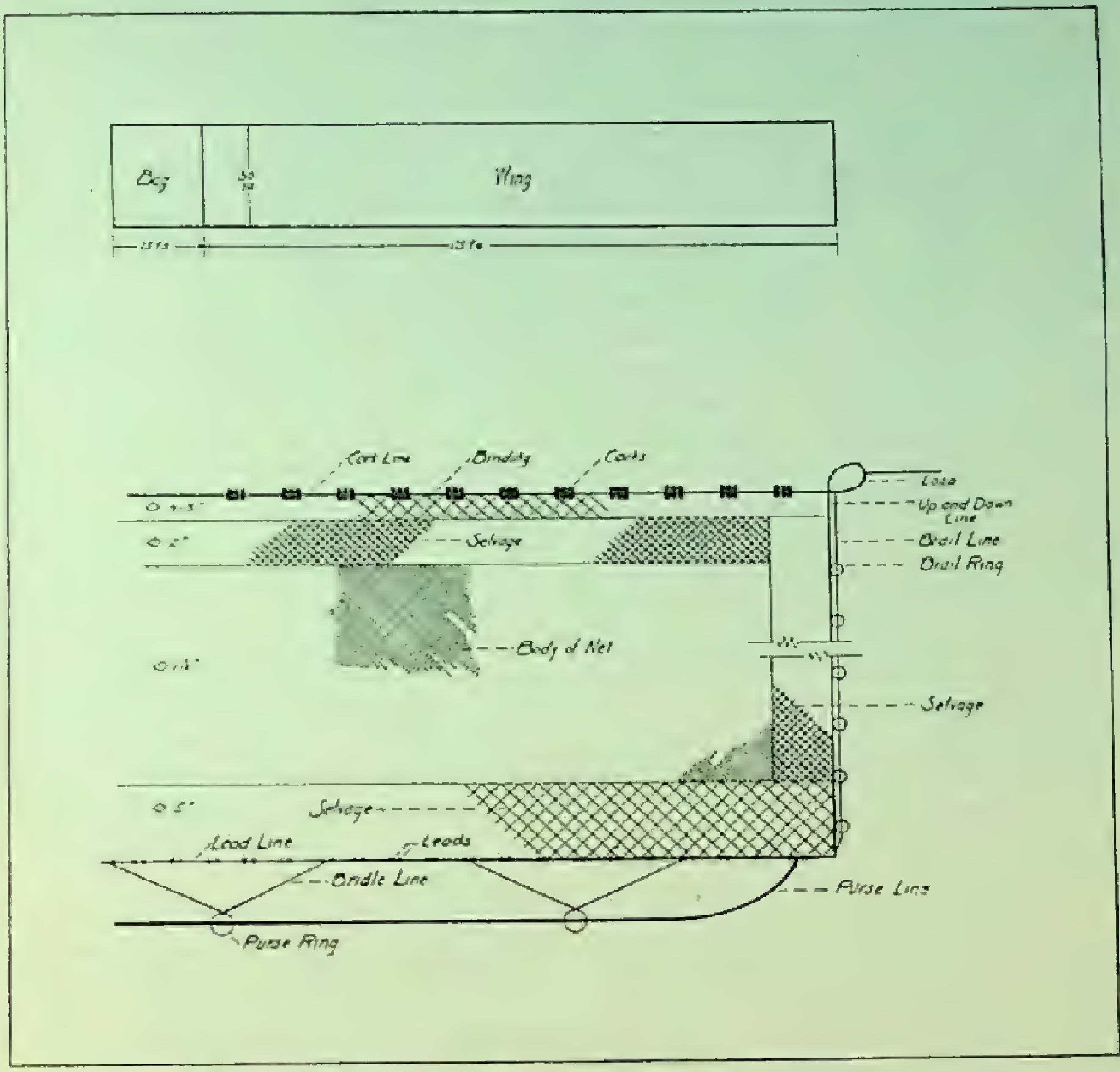


Fig. 77. (Top) Scale diagram of a typical purse seine showing relationship of bag and wing to total length and depth. (Bottom) Diagram showing constructional details of a typical sardine purse seine. (Not drawn to scale.)

It has been found that 1½-inch meshes frequently gill anchovies, which are occasionally present in some numbers along with the sardines. Any smaller mesh would make the net too heavy to handle when wet. Larger mesh would gill the sardines. A 1½-inch mesh is at best, then, a compromise.

Along the upper edge of the net is the cork line of ¾-inch (diameter) manila rope threaded through the corks. The cork line is shorter than the stretched webbing by about 10 per cent along the wing and 20 per cent along the bag. Thus, when the net is hung the top edge

of the webbing is hung slack along the cork line. The corks are 6 inches in diameter and 2 inches thick. They are put on in groups of three or four, the total number along the cork line depending on their condition; the number is greater if the corks are old and water-logged, and more are used on the tarred nets than on the tanned. The number is increased along the bag to support the additional weight of the bag and of the catch. Each group of corks is spaced about one foot apart. The binding attaching the cork line to the selvage (see Fig. 77) is almost invariably $1\frac{1}{2}$ meshes deep. The meshes of the binding are 4 or 5 inches, stretched measurement, and are made either of 60- or 84-thread line. The amount of selvage varies considerably, depending on the ideas of the particular fisherman, but is usually 12 or 24 meshes deep. These meshes are of 2-inch measurement, 24-thread line. From this selvage are hung the bag and wing of the net. Selvage on the bottom consists of 5-inch mesh, 27- or 30-thread line, is 50 meshes deep, and is attached directly to the lead line by means of 60-, 72- or 84-thread line. These meshes give additional strength and also facilitate the attaching of heavy lines to the borders of the net.

The lead line is $\frac{1}{2}$-inch manila rope and is 5 or 10 fathoms shorter than the cork line. Leads used are 4 ounces in weight and have a hole through their long axis through which the lead line is threaded. They are spaced in tanned nets about one every 10 inches along the wing, and one every 5 inches or sometimes closer along the bag. This number is increased by about one-third in tarred nets.

The 6-inch (inside diameter) galvanized iron purse rings are attached to the lead line at intervals of around 4 fathoms by means of 6-foot bridle lines of $\frac{1}{2}$-inch manila rope and hung about a fathom below the lead line. Through these rings is threaded the purse line. The latter is made of three sections—100 fathoms, 50 fathoms and 100 fathoms, respectively—joined by two links and a "figure-eight" shackle. This makes the purse line 50 fathoms longer than the net. The two end pieces are of $3\frac{1}{4}$-inch (circumference) manila rope and the shorter piece of $3\frac{3}{4}$- to 4-inch (circumference). The ends of this composite line are tied to the lead line at points about one fathom from each end of the net.

Along each end of the net is a vertical piece of selvage. The exact arrangement is a matter of choice, and it is usually 6, 12 or 24 meshes wide. These meshes are generally of the same weight and size as those in the bottom selvage.

At the upper corner of each end of the net, the cork line continues out to form a loop, then runs down the side of the net as the "up and down" line, and thence again horizontally as the lead line. Along the up and down line is attached a series of $3\frac{1}{2}$- to $3\frac{3}{4}$-inch (inside diameter) galvanized iron rings, called the brail rings. No bridle lines are used on these. The first brail ring is 2 fathoms from the loop, and the others are spaced at intervals of one fathom or a little more. Through these rings is run a brail line which is attached at one end to the loop and at the other close to the bottom of the up and down line. This is used to raise the lead line to the cork line at the beginning of the pursing operation. To one loop is attached the line that runs to the skiff, and to the other the line that is connected with the boat.

The piecing together of the many parts of a net is an operation requiring considerable skill. The difference in length between the lead and cork lines, and between the cork line and the netting, imparts a slight inward slope to the net when the fish are surrounded. If this slope is not just right, the net is said to "hang" improperly, and must then be taken down and rebuilt.

The net may be either tarred or tanned. During the past few years, tanned nets have been growing in favor. They have the advantage of being much lighter in weight and easier to handle, but have the disadvantage of having to be tanned at short intervals, usually once a month or oftener. A tarred net may go for a whole season or more without being retarred.

During the 1935–1936 season some of the purse seines in these waters have adopted a series of canvas or rubber floats as an aid in supporting the cork line. The balloon-like canvas floats, when inflated with air, are about 2 feet deep and 16 inches wide. Rubber floats are round and 2 feet in diameter. At the beginning of the pursing operations these floats, usually 5 or 6 in number, are clipped to the cork line along the bag end by the man in the skiff. In this way the cork line is prevented from sinking due to the weight of the fish in the bag.

About 1933, an innovation appeared on a few purse seines that has since been adopted by some fishermen. A small purse line is constructed along the cork line for a distance of some 10 or 15 fathoms from the bag end, or in some cases, from both the bag and the wing ends. A series of small purse rings of 3½ or 3¾ inches (inside diameter) is attached at intervals of 2 fathoms by means of short bridle lines. Through these rings is run a small purse line of ½-inch manila rope, tied at both ends to the cork line. The purpose of this is to aid in quickly bunching the corks and to prevent the cork line from drifting around the bow or stern of the boat. It is probable that in the course of time this miniature purse line will be adopted by all boats using the purse seine.

LITERATURE CITED

Fry, Donald H., Jr.
1930. The ring net, half ring net, or purse lampara in the fisheries of California. Calif. Div. Fish and Game, Fish Bull., no. 27, 65 pp., 28 figs.

Phillips, J. B.
1930. Success of the purse seine boat in the sardine fishery at Monterey, California (1929-1930 fishing season). Calif. Div. Fish and Game, Fish Bull., no. 23, 28 pp.

Scofield, W. L.
1926. Purse seines for California sardines. Calif. Fish and Game, vol. 12, no. 1, pp. 16-19.
1929. Sardine fishing methods at Monterey, California. Calif. Div. Fish and Game, Fish Bull., no. 19, 61 pp., 27 figs., 1929.

Skogsberg, Tage.
1925. Preliminary investigation of the purse seine industry of southern California. Calif. Div. Fish and Game, Fish Bull., no. 9, 95 pp., 23 figs.

Whitehead, S. S.
1931. Fishing methods for the bluefin tuna (*Thunnus thynnus*) and an analysis of the catches. Calif. Div. Fish and Game, Fish Bull., no. 33, 32 pp., 22 figs.

EMBRYONIC AND EARLY LARVAL STAGES OF THE CALIFORNIA ANCHOVY

Engraulis mordax Girard

By Rolf L. Bolin

While systematic work on California fishes has resulted in a comparatively satisfactory knowledge of the adult forms, the eggs and larvae of most species remain completely unknown. This paper is an effort to make possible the ready identification of the eggs and early larvae of one species, *Engraulis mordax* Girard.

There seems to be no limit to the spawning period of this fish, as eggs have been taken in the southern portion of Monterey Bay during each month in the year. Material at hand indicates that most of the spawning takes place from December to June for the eggs are rather uncommon during summer and fall.

When eggs are numerous, each haul made in the forenoon contains eggs in three distinct developmental stages. Of these the oldest hatch at about noon, while the intermediate and youngest groups require an additional 24 and 48 hours respectively. Although no eggs were observed before cleavage had set in, the condition of the earliest stages caught and the established rate of development indicate that this species lays its eggs regularly at about 10 o'clock in the evening, the larvae hatching out about 62 hours later. The peculiarity of regular spawning seems to be typical of anchovies and has been noted in other species by Eigenmann (1893), Kuntz (1915) and Kuntz and Radcliffe (1918).

The eggs of *Engraulis mordax* are variable in size and shape. They differ from the orthodox spherical fish eggs in being ellipsoidal with a major axis of from 1.23 to 1.55 mm. and a minor axis of from 0.65 to 0.82 mm. During the early developmental stages, their specific gravity is slightly less than that of sea water. At this time, if placed in a finger bowl of sea water, they float at the surface, but their buoyancy is so slight that the least current sends them down. Since the protoplasm constitutes the heaviest part of the egg, the early stages float with the blastoderm at the lower end of the perpendicular major axis. As the embryo advances, the egg rolls over on its side so that the major axis becomes horizontal and the embryo hangs underneath. The specific gravity differs so slightly from that of sea water that, some hours before hatching, the embryo attains a size and weight sufficient to cause the egg to sink slowly.

The eggs are colorless and almost completely transparent, and the egg membrane is very thin and delicate, showing no sculpturing nor markings. There are no oil globules. The yolk is composed of separate masses and gives the appearance of being made up of large cells. This character is typical of anchovy eggs in general.

Unfortunately, due to lack of success in stripping and fertilizing, no eggs were observed in the early stages of the formation of the

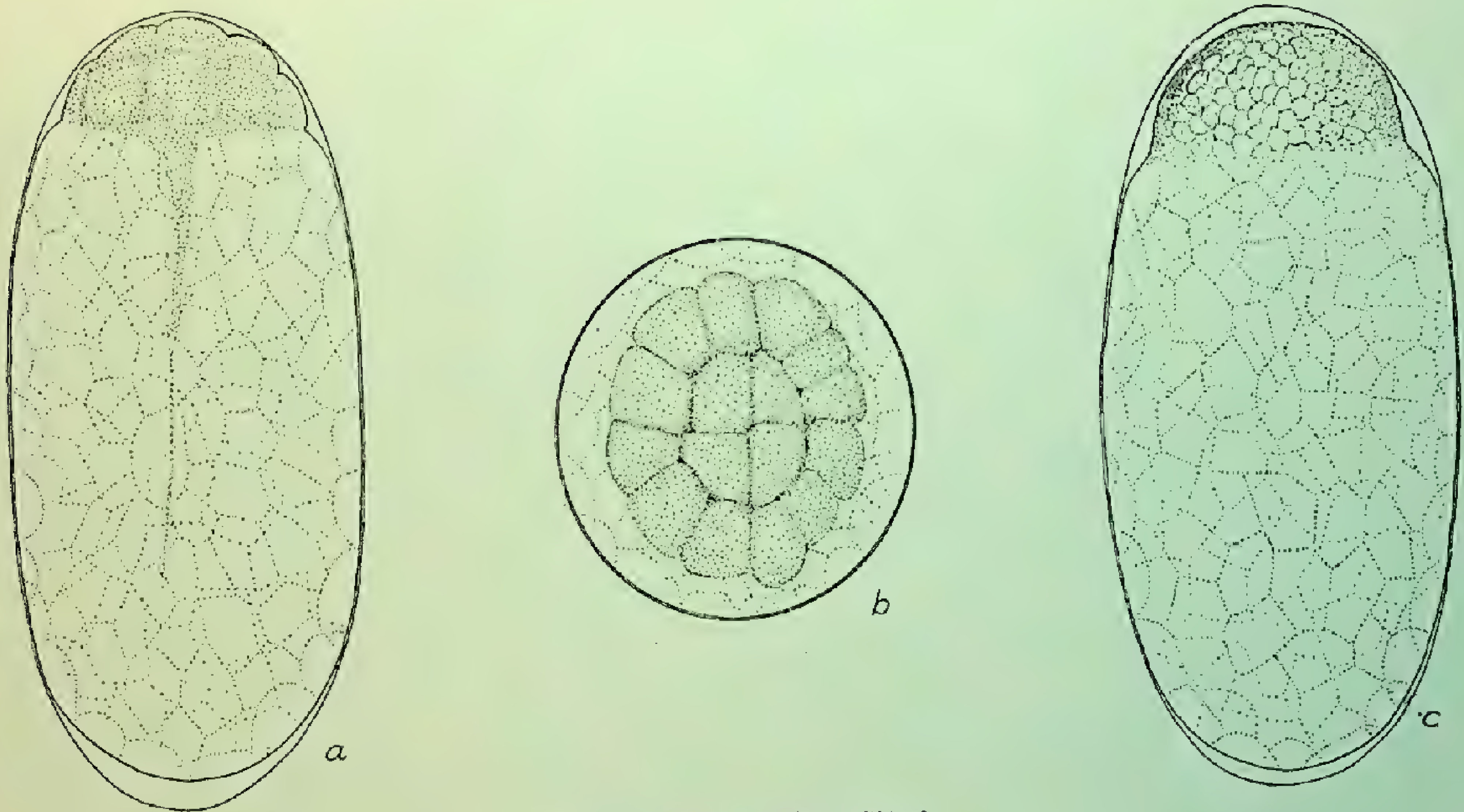


FIG. 78. *Engraulis mordax* Girard.
a. Egg in 16-cell stage. Side view.
b. Same. End view.
c. Egg with well developed blastoderm.

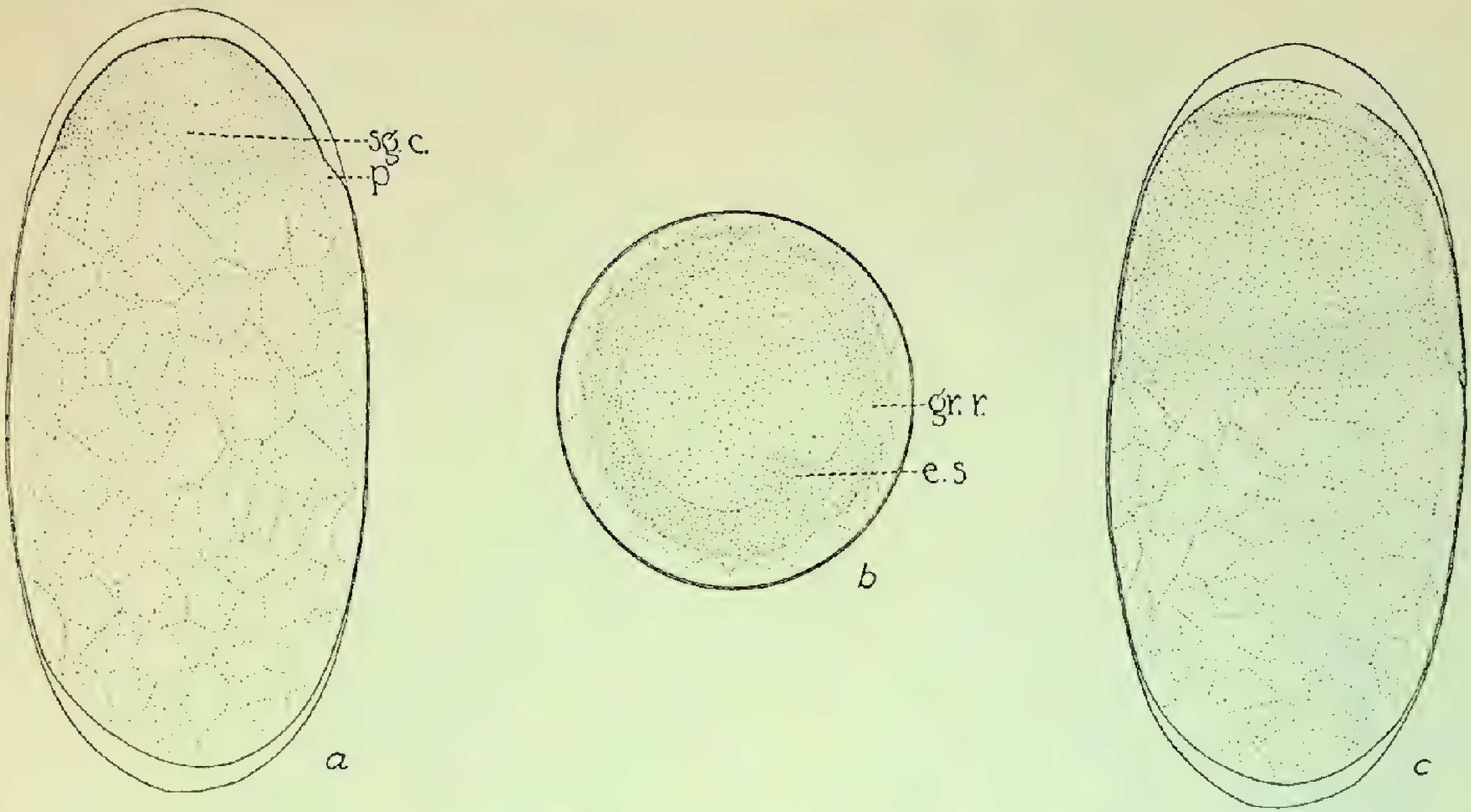


FIG. 79. *Engraulis mordax* Girard.

a. Egg with segmentation cavity (sg. c.) and periblast (p) well developed.
b. Egg showing germ ring (gr. r.) and embryonic shield (e. s.).
c. Egg with embryonic axis well established.

blastodisc. The great degree of similarity between the later stages of the eggs of *Engraulis mordax* and those of the previously investigated species of anchovies, indicates that the early stages may also be very similar. A brief quotation from Kuntz's excellent paper on *Anchovia mitchilli* (1915), may thus serve to illustrate the probable early development of the species under discussion.

"The eggs of *Anchovia mitchilli* are not spherical but slightly elongated. As the thin protoplasmic layer investing the yolk becomes concentrated to form the blastodisc, the protoplasm 'streams' toward one pole of the major axis. When fully differentiated the blastodisc appears as a lenticular cap of protoplasm lying on the somewhat flattened lower end of the yolk mass. The periphery of the blastodisc fades away almost imperceptibly into the very thin layer of protoplasm which remains at the surface of the yolk. Between the thin egg membrane and the delicate vitelline membrane there is now a perceptible perivitelline space. Cleavage in these eggs advances with great regularity."

The youngest egg which I have had an opportunity to observe was in the eight cell stage, but within a few minutes, before it could be carefully studied, it divided again, forming sixteen cells (Fig. 78, a and b). When first examined, this egg had a streak of finely granular material, similar in appearance to the protoplasm of the blastomeres, extending from the blastoderm along the major axis of the egg. This is shown in Fig. 78a. Whether this structure was due to a pathological condition of the egg in question or whether it is typical of the eggs of *Engraulis mordax*, I do not know. The streak grew rapidly thinner and disappeared entirely before the fifth cleavage took place.

Later cleavages take place regularly at intervals of one-half hour or slightly less and result in the formation of a high, somewhat constricted blastoderm with the periphery fading into the extremely thin layer of protoplasm investing the yolk (Fig. 78c). As development progresses, the blastomeres become smaller and the edges of the blastoderm begin to slope more gently. While the blastoderm as a whole finally assumes a dome shape, most of the thin layer of protoplasm still investing the yolk becomes concentrated around the periphery of the blastoderm in the form of a flattened ridge, the periblast. The periblast begins to form during early cleavages, but does not become distinct until rather late stages, when the blastoderm is more definitely deliminated peripherally.

As soon as the blastoderm has assumed a symmetrical dome shape, the segmentation cavity becomes apparent beneath its central area (Fig. 79a). Shortly thereafter invagination begins. The resulting germ ring is distinctly visible when the egg is viewed from the end (Fig. 79b). Since in *Engraulis mordax* the rapid proliferation of cells at the posterior pole is limited to a small portion of the germ ring, the resulting embryonic shield is very narrow.

A thickening soon occurs along the median line of the embryonic shield, representing the axis of the embryo. This thickening results in a prominent dorsal ridge protruding into the perivitelline space and in a less developed ventral ridge causing the formation of a shallow V-shaped groove in the yolk.

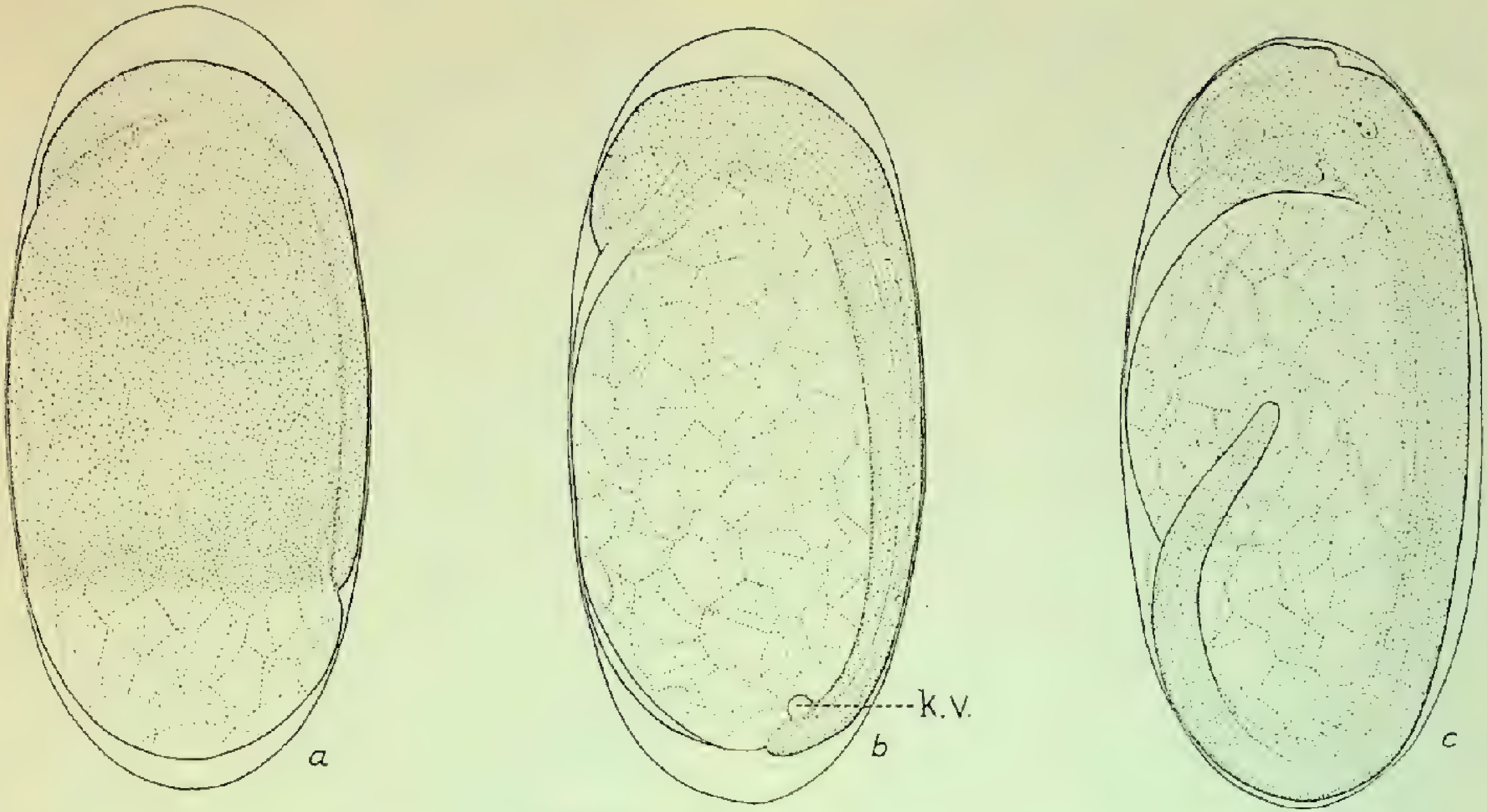


FIG. 80. *Engraulis mordax* Girard.
a. Egg shortly before closure of blastopore.
b. Egg shortly after closure of blastopore, showing Kupffer's vesicle (k. v.).
c. Egg shortly before hatching.

Soon after the germ ring has been differentiated, the blastoderm begins a rapid growth down over the yolk (Fig. 79c). The posterior pole does not remain at a fixed point as it does in the eggs of most teleosts, but recedes as the anterior end of the embryo advances, the blastopore closing at the vegetal pole. Until the time of the closure of the blastopore there is almost no visible differentiation in the embryo itself (Fig. 80a). It appears merely as a simple, undifferentiated ridge of protoplasm extending slightly more than half way around the yolk mass and with its anterior end somewhat enlarged and depressed into the yolk. As soon as the blastopore has closed, however, rapid changes take place; the eyes become visible; segmentation appears; and Kupffer's vesicle arises as a bubble-like body, imbedded in the yolk near the posterior end of the embryo (Fig. 80b). Kupffer's vesicle soon reaches its maximum development and then declines in size and disappears within a few hours. As soon as this structure disappears, the tail becomes free and increases rapidly in length. Meanwhile the pupils of the eyes become visible, the small auditory capsules containing two otoliths appear, the heart develops and may be seen beating just posterior to and below the eye, and the median fin fold is formed and may be observed when the embryo moves (Fig. 80c). The tail is flexed to the right or to the left soon after becoming free, but it never grows to such an extent that it reaches the head.

A few hours before hatching the embryo becomes active, but its movements are limited to swinging the tail from one side to the other. It never rolls over within the shell as do the embryos of most fishes. The form of the egg is probably partially responsible for this, but all of the movements of the embryo are comparatively weak.

The newly-hatched larvae are about 3 mm. in length. The yolk sac is rather large and elongated and tapers to a point posteriorly. The yolk still retains the cellular appearance which is so striking in the egg. The head is distinctly deflected at the anterior end of the yolk sac, and there is no indication of mouth or jaws (Fig. 81a). The dorsal fin fold has its origin far forward on the head and is continuous with the ventral fold which originates on the ventral side of the yolk sac. The depth of each fold is approximately equal to the depth of the body. The vent is located at a point about midway between the posterior end of the yolk sac and the tip of the tail. The entire embryo is almost completely transparent: there is no indication of any pigmentation, even in the eyes.

Attempts to rear *Engraulis* were unsuccessful, as all of the larvae died at the end of five days. During this short time, however, they undergo a series of striking changes which alter their entire appearance (Fig. 81b). The yolk sac is entirely absorbed in thirty-six hours and meanwhile the head becomes elevated from its deflected position. The eyes soon develop black pigment and the auditory capsules, which at the time of hatching are hardly as large as the pupils, rapidly increase in size until they are considerably larger than the whole eye. The pectoral fins soon become rather large and the posterior end of the intestine increases greatly in size and at the same time shows a series of cross markings which are probably the first indication of the

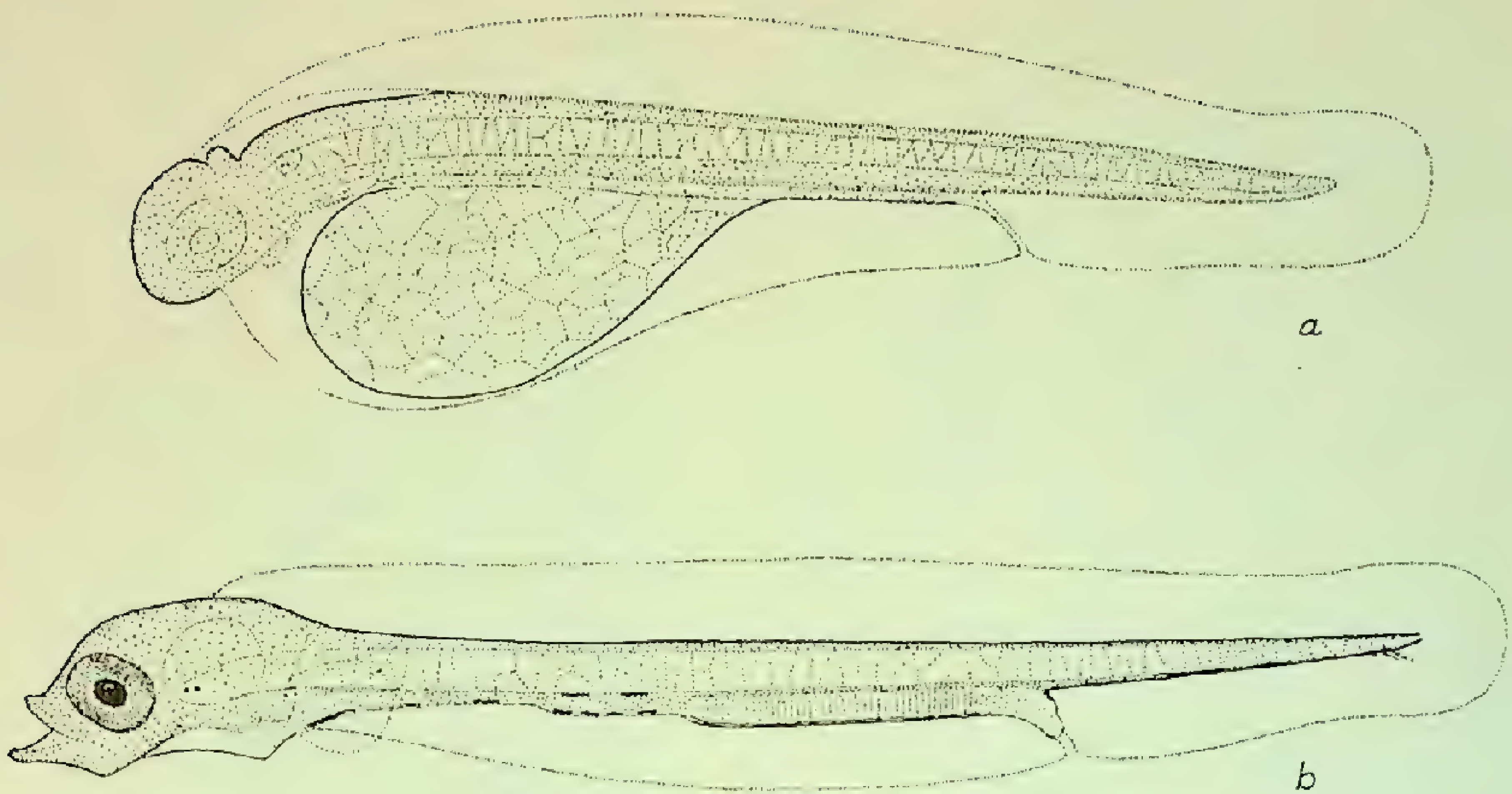


Fig. 81. *Engraulis mordax* Girard.

a. Newly hatched larva.

b. Five-day larva.

intestinal convolutions which occur in other anchovy larvae at about this stage.

On the fourth day after hatching the mouth is apparently functional. The lower jaw is long and protruding. On the fifth day a few elongate melanophores are to be found along the ventral border of the body extending in an irregular series from the base of the pectoral fins half way to the vent. Another series occurs on the ventral margin of the tail and a small patch of melanophores near the tip of the tail sends short processes posteroventrally into the fin fold.

LITERATURE CITED

Eigenmann, Carl H.
1893. The fishes of San Diego, California. *Proc. U. S. Nat. Mus.*, 58: 123–178.

Kuntz, Albert.
1915. The embryology and larval development of *Bairdiella chrysura*, and *Anchovia mitchilli*. *Bull. U. S. Bur. Fish.*, 33: 1–19

Kuntz, Albert, and Radcliffe, Lewis.
1918. Notes on the embryology and larval development of twelve species of teleostean fishes. *Bull. U. S. Bur. Fish.*, 34: 409–429.

Hydrobiological Survey, Hopkins Marine Station, Pacific Grove, California.

CALIFORNIA FISH AND GAME

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THE TWENTY YEAR INDEX

The twenty year index to CALIFORNIA FISH AND GAME which appears in this issue will add materially to the use and value of the periodical. It is so placed that it may be cut off and bound separately.

Through these twenty years the character of its content has varied somewhat but the aim of the magazine, the "Conservation of Wild Life Through Education" has not been lost to view. It has been in large measure devoted to the accomplishments of the Division of Fish and Game, and it will stand as a record of its growth, expansion and development as an agency of conservation.

Through the many numbers and the varied articles there runs the theme that measures or means of conservation and their rational application or administration rest entirely upon what is learned from careful research. Research in this case includes the discovery of facts and their interrelations. Sound measures of conservation can rest upon nothing else, while laws and regulations resulting from hearsay and guesses are futile, even harmful. Conservation requires first of all a thorough knowledge of the situation and then a willing or enforced cooperation of all concerned in carrying out such measures as have been devised. Many who have carefully considered conservation in its broadest sense have concluded that education of the public and especially of its younger members should form an essential part of the program.—*J. O. S.*

EXPERIMENTAL INTRODUCTION OF SALMON INTO KLAMATH RIVER

The Division of Fish and Game is attempting to reestablish spring run salmon in the Klamath River. These fish which were once abundant and formed a large part of the catch have been greatly depleted. The peak of the present run comes in August and it would be a great advantage to again have salmon entering the river during the spring and early summer months.

During each of the last two years eggs of Columbia River spring king salmon have been obtained by exchange with the State of Oregon. These eggs have been held for hatching at the Fall Creek Hatchery of the Division, which is just below Copco dam. In 1935 after the fish had been reared to an average length of over three inches, 40,000

of them were marked by cutting off the ventral fins and they, together with the unmarked balance, were planted in Fall Creek. The total planted in 1935 was 88,000. 28,600 were marked and 134,000 planted during the present year, and the experiment will be continued, if possible, for a year or two until it is definitely determined what results are being obtained. The marking of these fish will make it possible to distinguished them from the regular run both at the mouth of the Klamath and at the egg-taking stations of the upper river. Should this trial prove successful it will be followed with further propagation of this type of fish which should greatly extend the sport fishing for salmon at the mouth of the Klamath.

The eggs were obtained through the kindly interest of Hugh C. Mitchell of the Oregon Fish Commission. The experimental work is under the direction of Alan H. Taft.—*J. O. S.*

KING SALMON IN SOUTHERN CALIFORNIA, 1936

The extreme southern range of the king salmon (*Oncorhynchus tschawytscha*) on the American coast seems to be southern California. Nearly every summer a few are caught by commercial net fishermen in the neighborhood of San Pedro. These, of course, are taken accidentally by fishermen seeking other kinds of fish.

During the early summer of 1936, at least three king salmon were caught in southern California by sport fishermen using hook and line. In addition to these authentic records, there were several unverified reports of salmon being caught.

The first definite record was of a 29-pounder caught in Santa Monica Bay on May 16, 1936. The lucky angler was Harold Riddell who was fishing with live bait on the passenger fishing boat *Ramona*, which operates out of Ocean Park.

The second one was the farthest south of the three. It was taken from Scripps Pier at La Jolla on June 3. This fish, which weighed four pounds, was identified as a king salmon by Dr. P. S. Barnhart, ichthyologist at the Scripps Institution of Oceanography, La Jolla.

The party fishing boat *Sunshine I* of Newport, fishing off San Clemente in southern Orange County, accounted for the third salmon. It was a 20-pounder and struck at its last sardine on June 5.—*Richard S. Croker, California State Fisheries Laboratory, July 30, 1936.*

NEW METHOD OF SHIPPING TUNA FROM JAPAN

On August 3, 1936, the Italian Food Products Company, Inc., of Long Beach received for canning purposes five tons of "boned and frozen" bluefin tuna from Japan as a trial experiment. The fish were halved or quartered, depending on the size of the individuals. These halves and quarters weighed from about 39 to over 60 pounds each. The meat side of the fillet was covered with a piece of glazed paper and the whole piece wrapped, sewed and tied in a piece of cheese cloth.

Due to the difficulty experienced in the past in shipping large whole fish from the Orient, this experiment was made. A loss due to spoilage was generally encountered because these large fish, which are very thick, could not be satisfactorily frozen and thawed.—*L. G. Van Vorhis, Division of Fish and Game, August 3, 1936.*

CARL WESTERFELD

Carl Westerfeld, former commissioner and executive officer of the Division of Fish and Game, died in San Francisco. Although not in the best of health for the past few years his passing was a distinct shock to his host of friends.

Mr. Westerfeld was appointed to the Board by Governor Johnson on January 2, 1912. On December 8, 1916, he resigned and was appointed Executive Officer by Commissioners Newbert, Connell and Bosqui, serving in that capacity until April 28, 1920.

During Mr. Westerfeld's term of service, the progress in conservation was rapid and definite. A true sportsman himself and with a thorough understanding of conservation problems, he made an ideal officer.

Two sisters, Mrs. H. R. Heitel of Pasadena and Mrs. J. H. Ankele of San Francisco are the only near relatives.—*J. S. H.*

Captain E. W. Smalley, for many years a field deputy of the Division, died Sunday, August 9, 1936, at the home of his daughter in Lomita Park.

First appointed May 1, 1909, he served continuously until the time of his death. Although his headquarters were always at Hanford, his work took him to all parts of the San Joaquin Valley. With the late S. N. L. Ellis, he should be credited with being largely responsible for the extension of the range of Golden Trout in the south Sierra.

Always loyal and ever giving his best efforts to the conservation cause, he deserves a place in the front rank of those who have made conservation their life work.

Services were held in Hanford by the officers of the Hanford Lodge of Elks. His wife, a daughter, two sons and six grandchildren mourn his passing.—*J. S. H.*

REPORTS

STATEMENT OF REVENUE

For the Period July 1, 1935, to June 30, 1936, of the Eighty-seventh Fiscal Year

Revenue for the Fish and Game Preservation Fund, Current Year:		
License sales:		
Angling licenses, 1935	$374,800 50	
Angling licenses, 1936	166,829 00	
Commercial hunting club licenses, 1934-1935	-------------	
Commercial hunting club licenses, 1935-1936	950 00	
Commercial hunting club operators' licenses, 1935-1936	215 00	
Deer tags, 1935	110,804 00	
Deer tags, 1936	3 00	
Fish breeders' licenses, 1935	25 00	
Fish breeders' licenses, 1936	320 00	
Fish importers' licenses, 1935	10 00	
Fish importers' licenses, 1936	85 00	
Fishing party vessel permit, 1936	210 00	
Fish packers' and wholesale shell fish dealers' licenses, 1935-1936	1,040 00	
Game breeders' licenses, 1935	160 00	
Game breeders' licenses, 1936	1,145 00	
Hunting licenses, 1934-1935	22,205 00	
Hunting licenses, 1935-1936	348,002 00	
Hunting licenses, 1936-1937	47 00	
Kelp licenses, 1935	10 00	
Kelp licenses, 1936	30 00	
Market fishermen's licenses, 1935-1936	35,150 00	
Market fishermen's licenses, 1936-1937	28,100 00	
Trapping licenses, 1935-1936	1,532 00	
Total license sales		$1,091,672 50
Other income:		
Court fines	$49,469 32	
Fish packers' tax	278,498 82	
Fish tag sales	3,120 66	
Game tag sales	169 62	
Importers' contributions	541 00	
Interest on bank balances	6,825 65	
Kelp tax	214 78	
Lease of kelp beds	1,025 60	
Miscellaneous sales	3,424 26	
Publication sales	686 47	
Salmon tax—Chap. 1015-35	1,998 78	
Total other income		345,974 96
Total Fish and Game Preservation Fund		$1,437,647 46
Revenue for the General Fund, Current Year:		
Unclaimed checks and deposits		38 90
Grand total all funds		$1,437,686 36

STATEMENT OF EXPENDITURES

For the Period July 1, 1935, to June 30, 1936, of the Eighty-seventh Fiscal Year

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
OPERATING EXPENDITURES, EIGHTY-SEVENTH FISCAL YEAR					
Administration:					
Executive	$4,999 02				$4,999 02
Clerical and office	5,520 00	$1,483 40	$830 89	$189 16	8,023 45
Printing, general		4,705 37			4,705 37
Automobiles		471 49	311 32		782 81
Traveling			3,625 30		3,625 30
Postage			4,463 80		4,463 80
Telephone and telegraph			5,542 42		5,542 42
Freight, cartage and express			976 84		976 84
Rent			12,115 15		12,115 15
Accident and death claims			3,643 08		3,643 08
Accounting pro rata	13,000 00				13,000 00
Legal			4,934 63		4,934 63
Publicity			1,328 91		1,328 91
Printing fish and game magazine		3,210 99			3,210 99
Premiums on bonds			35 00		35 00
Photography			20 28		20 28
Library	1,680 00	147 68	64 46	186 28	2,078 42
Pro rata General Fund expense, Chap. 923-33			5,176 12		5,176 12
Federal cooperation	360 00				360 00
Total Administration	$25,559 02	$10,018 03	$43,068 20	$375 44	$79,022 49
Bureau of Patrol and Law Enforcement:					
Chief and assistants	$11,100 00				$11,100 00
Clerical and office	5,094 66	$57 36	$37 13	$109 80	5,298 95
Automobile		33,717 66	12,559 54	24,958 38	71,235 58
Traveling			50,355 90		50,355 90
Postage			797 90		797 90
Telephone and telegraph			1,567 07		1,567 07
Freight, cartage and express			7 66		7 66
Rent			514 19		514 19
Captains and wardens	187,192 58	754 58	848 88	111 24	188,907 28
Launches		2,985 85	1,794 20	409 51	5,189 56
Heat, light, water and power			7 63		7 63
Fish planting	4,572 33	647 56	2,909 15	3 00	8,132 01
Temporary help	253 33				253 33
Premiums on bonds			415 24		415 24
Commercial fisheries patrol:					
Superintendent	2,790 00				2,790 00
Captains and wardens	12,120 00	11 79	139 53		12,271 32
Launches	12,725 98	6,014 98	5,231 42	269 35	24,241 73
Fish cannery inspectors, seasonal	14,388 03		580 91		14,968 94
Rent			945 70		945 70
Automobiles		358 91	390 68		74 59
Temporary help	108 87				108 87
Total Bureau of Patrol and Law Enforcement	$250,345 78	$44,518 69	$79,103 63	$25,861 28	$399,859 38
Bureau of Commercial Fisheries:					
Chief and assistants	$11,093 68		$2,385 00		$13,478 68
Clerical and office	9,490 00	$23 51	42 79	$101 07	9,657 37
Automobiles		574 36	196 37		770 73
Traveling			7,569 93		7,569 93
Telephone and telegraph			718 80		718 80
Fish tags		389 13			389 13
Hydro-Biological Survey, Monterey Bay			1,000 00		1,000 00
Freight, cartage and express			271 90		271 90
Heat, light, water and power			417 75		417 75
Rent			144 37		144 37
Research	2,280 00	62 29	26 55		2,368 84
Laboratory	25,759 67	3,287 14	507 43	2,261 81	31,816 05
Cooperative research			3,600 00		3,600 00
Statistics		1,924 98	2,182 39	776 18	4,883 55
Temporary help	467 93				467 93
Terminal Island grounds	425 82	1 37	232 62	6 76	666 57
Total Bureau of Commercial Fisheries	$49,517 10	$6,262 78	$19,295 90	$3,145 82	$78,221 60

STATEMENT OF EXPENDITURES

For the Period July 1, 1935, to June 30, 1936, of the Eighty-seventh Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Bureau of Fish Conservation:					
Chief and assistants	$7,260 00				$7,260 00
Clerical and office	5,297 87	$51 74	$10 50	$31 90	5,392 01
Automobiles		8,845 05	4,082 09	2,371 33	15,298 47
Traveling			10,519 00		10,519 00
Postage			222 06		222 06
Telephone and telegraph			1,321 78		1,321 78
Freight, cartage and express			863 43		863 43
Rent			3,247 54		3,247 54
Heat, light and power			1,860 53		1,860 53
Hatcheries	110,095 79	93,216 94	1,274 45	2,963 29	207,550 47
Fish cars	3,320 17	345 67	3,139 62	1 96	6,807 42
Blue Printing			59 93		59 93
Cooperative research	3,035 59	1,054 66	972 94	21 04	5,084 23
Temporary help	1,475 76				1,475 76
Fish hatchery assistants, seasonal	26,391 53				26,391 53
Special field	13,560 00	275 04	19 40	391 91	14,246 35
Fish rescue	1,935 16	603 92	1,923 33	549 68	5,012 09
Statistics	273 55	42 20	1 72	582 64	900 11
Total Bureau of Fish Conservation	$172,645 42	$104,435 22	$29,518 32	$6,913 75	$313,512 71
Bureau of Hydraulics:					
Chief and assistants	$5,152 35	$25 08	$995 84		$6,173 27
Traveling			1,000 52		1,000 52
Clerical and office	1,920 00	18 24	142 14	$124 75	2,205 13
Automobiles		146 04	41 55	898 78	1,086 37
Cooperative research		13 55			13 55
Photography			2 18		2 18
Heat, light, water and power			34 52		34 52
Research		23 40			23 40
Temporary help	72 59				72 59
Blue printing			27 18		27 18
Total Bureau of Hydraulics	$7,144 94	$226 31	$2,243 93	$1,023 53	$10,638 71
Bureau of Game Conservation:					
Chief and assistants	$14,781 63				$14,781 63
Clerical and office	2,960 00	$50 27		$248 53	3,258 80
Automobiles		2,364 22	$1,094 84	903 51	4,362 57
Traveling			6,455 98		6,455 98
Postage			2 03		2 03
Telephone and telegraph			358 84		358 84
Freight, cartage and express			85 13		85 13
Heat, light, water and power			4,122 22		4,122 22
Maintenance	12,753 38	11,868 10	359 87	233 45	25,214 80
Temporary help	2,538 09				2,538 09
Quail trapping and expansion of quail program	3,620 00	101 02	173 66		3,894 68
Refuge posting	486 29				486 29
Statistics	1,570 84	1,058 78	168 96	569 98	3,368 56
Refuge maintenance	5,502 68	2,102 05	2,576 37	11 76	10,192 86
Temporary help, seasonal	3,440 32				3,440 32
Rent			300 00		300 00
Total Bureau of Game Conservation	$47,653 23	$17,544 44	$15,697 90	$1,967 23	$82,862 80
Bureau of Licenses:					
Clerical and office	$12,604 51	$259 49	$151 67	$200 31	$13,215 98
Printing, licenses and applications		6,084 06	529 40		6,613 46
Postage			2,361 63		2,361 63
Temporary help	1,160 32				1,160 32
Freight, cartage and express			128 01		128 01
Premiums on bonds			1,240 50		1,240 50
Identification license buttons		10,399 22			10,399 22
License commissions			49,784 12		49,784 12
Total Bureau of Licenses	$13,764 83	$16,742 77	$54,195 33	$200 31	$84,903 24
Special Item:					
State Fair and other exhibits (payable from support)	$40 50	$113 48	$1,274 30		$1,428 28
Total Special Items	$40 50	$113 48	$1,274 30		$1,428 28
Total eighty-seventh fiscal year expense paid from support appropriations	$566,671 72	$159,892 62	$244,307 51	$39,457 36	$1,050,449 21

STATEMENT OF EXPENDITURES

For the Period July 1, 1935, to June 30, 1936, of the Eighty-seventh Fiscal Year—Continued

Function	Salaries and wages	Materials and supplies	Service and expense	Property and equipment	Total
Special Items:					
Claim of Chief Accounting Officer of Department of Finance			$1,516 76		$1,516 76
Support of Napa State Farm			6,387 50		6,387 50
Predatory Animal Control:					
Lion hunters	$4,080 67				4,080 67
Predatory animal control		$769 35	5,602 28		6,371 63
Predatory animal hunters and trappers, seasonal	6,200 00				6,200 00
Automobiles			26 99	$2,512 12	2,539 11
Traveling			898 50		898 50
Total Predatory Animal Control	$10,280 67	$769 35	$6,527 77	$2,512 12	$20,089 91
Total Special Items	$10,280 67	$769 35	$14,432 03	$2,512 12	$27,994 17
Total Expenditures for Additions and Betterments:					
Permanent Improvements:					
Construction, improvements and equipment and purchase of game refuges and public shooting grounds, Chap. 341-35	$10,336 65	$18,911 09	$12,348 24	$30,110 28	$71,706 26
Contributions to Employee's Retirement System					18,038 86
Total Expenditures, eighty-seventh fiscal year from current biennium					$1,168,188 50
Prior Biennium Appropriations:					
Eighty-seventh fiscal year:					
Operating Expenditures:					
Special items:					
California Code Commission Expenses, Chap. 645-33				$635 48	
Construction Russian River jetties				406 37	
Total Operating Expenditures, eighty-seventh fiscal year					$1,041 85
Expenditures for Additions and Betterments: Construction, improvements and equipment, Chap. 278-33	$2,691 89	$9,511 82	$2,443 59	$17,452 07	$32,099 37
Eighty-sixth fiscal year:					
Operating Expenditures:					
Support				$0 05	
Fresh fish marketing				2 19	
Special item: License commissions				92	
Total Operating Expenditures, eighty-sixth fiscal year					$3 16
Eighty-fifth fiscal year:					
Operating Expenditures:					
Support				$4 20	
Special Item:					
Claim of Chief Accounting Officer of Dept. of Finance, Chap. 991-33				35 50	
Total Operating Expenditures, eighty-fifth fiscal year					$39 70
Total prior biennium appropriations					$33,104 68
Grand total proprietary group					$1,201,293 18

SEIZURES OF FISH AND GAME

April, May, June, 1936

Game:	
Deer	6
Deer hides	6
Deer meat, quart jars	4
Deer meat, pounds	444
Dove	3
Geese	5
Pheasant	3
Quail	10
Rabbit	51
Fish:	
Abalone	538
Bass, Black	59
Bass, Black, pounds	5½
Bass, Striped	169
Bass, Striped, pounds	405
Bass, White Sea, pounds	1,150
Carp	20
Clams	1,618
Cockles	820
Crab	19
Crappie	149
Croker, Yellowfin	40
Mullet, pounds	157
Perch	14
Shad, pounds	30
Sunfish	386
Trout	439
Tuna, pounds	4,485

FISH CASES

April, May, June, 1936

Offense	Number arrests	Fines imposed	Jail sentences (days)
Abalone; drying; overlimit; undersize; taken below high-water line	88	$2,040 00	----
Angling; closed season; closed stream; no license; within 150 ft. of dam; within 250 ft. of fishway	156	2,443 00	202½
Bait; using trout roe	4	100 00	----
Bass, Black; closed season; undersize	10	232 50	160
Bass, Striped; illegal disposition; offering for sale; overlimit; undersize	22	560 00	360
Bass, White Sea; undersize	1	100 00	----
Clams; overlimit; possession instrument in preserve; undersize	24	675 00	125
Commercial fishing; no license	48	65 00	15
Crabs; undersize	22	470 00	20
Fishing with prohibited gear	5	152 50	----
License; failure to show on demand; false statement	4	60 00	----
Lobsters taken in traps	1	----	----
Net; illegal	10	605 00	----
Night fishing	5	25 00	----
Receipt; failure to record	2	----	----
Sardines; illegal use of	1	200 00	----
Spear; possession within 300 ft. of stream	3	30 00	----
Trout; closed season; overlimit	34	700 00	10
Totals	440	$8,448 00	892½

GAME CASES

April, May, June, 1936

Offense	Number arrests	Fines imposed	Jail sentences (days)
Deer; closed season; evidence of sex removed; kill and possess doe	26	$2,555 00	725
Ducks; closed season; overlimit	4	175 00	
Firearms in refuge	4	75 00	
Game birds; closed season	4	115 00	
Hunting; closed season; no license; using spotlight	40	620 00	627½
Illegal shooting	2	50 00	
License; using another's	1	50 00	
Night hunting	1	25 00	
Pheasant; closed season; possession untagged	6	115 00	
Quail; closed season	3	125 00	10
Rabbits; closed season	5	90 00	
Totals	96	$3,995 00	1,362½

FRESH FISH IMPORTATIONS BY POINT OF ORIGIN* FOR APRIL, MAY AND JUNE, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Gulf of California	West Coast Lower California	International waters south U. S. boundary (definite origin unknown)	Mexican mainland, Central and South America	Japan	Total pounds
Barracuda		80,465				80,465
Cabrilla	16,475	93,933				110,408
Corbina, Mexican	15,112	17				15,129
Cultus, Pacific		212				212
Grouper		21,060				21,060
Halibut, California		151,655				151,655
Mackerel, Pacific		110,025				110,025
Rock Bass		34,466				34,466
Rockfish		12,686				12,686
Sablefish		210				210
Sardine		65				65
Sculpin		121				121
Sea-bass, Black		101,486				101,486
Sea-bass, Totuava	122,138					122,138
Sea-bass, White		22,648				22,648
Shark		3,666				3,666
Sheepshead		1,236				1,236
Skate		1,063				1,063
Smelt		17				17
Swordfish, Broadbill		2,684				2,684
Tuna, Albacore					292,554	292,554
Tuna, Bluefin		3,583,776				3,583,776
Tuna, Bonito		165,276				165,276
Tuna, Skipjack	541,629	740,849	2,654,264	305,165	135,316	4,377,223
Tuna, Yellowfin	2,624,912	763,310	14,501,935	5,968,335		23,858,492
Whitefish		2,751				2,751
Yellowtail		2,018,445	2,875			2,021,320
Miscellaneous Fish		501				501
Crustacean:						
Shrimp	9,506					9,506
Reptile:						
Turtle		546				546
Total pounds	3,329,772	7,913,169	17,159,074	6,273,500	427,870	35,103,385

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

FRESH FISH IMPORTATIONS* FROM FOREIGN COUNTRIES FOR APRIL, MAY AND JUNE, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Landed in Region 70, Los Angeles	Landed in Region 80, San Diego	Total pounds
Barracuda	1,062	79,403	80,465
Cabrilla	48,366	62,042	110,408
Corbina, Mexican	15,112	17	15,129
Cultus, Pacific		212	212
Grouper	8,723	12,337	21,060
Halibut, California	37,308	114,347	151,655
Mackerel, Pacific		110,025	110,025
Rock Bass	3,236	31,230	34,466
Rockfish	585	12,101	12,686
Sablefish		210	210
Sardine		65	65
Sculpin		121	121
Sea-bass, Black	76,172	25,314	101,486
Sea-bass, Totuava	122,138		122,138
Sea-bass, White	2,282	20,366	22,648
Shark	2,013	1,653	3,666
Sheephead	570	666	1,236
Skate	1,000	63	1,063
Smelt		17	17
Swordfish, Broadbill	162	2,522	2,684
Tuna, Albacore	292,554		292,554
Tuna, Bluefin	3,381,177	202,599	3,583,776
Tuna, Bonito	292	164,984	165,276
Tuna, Skipjack	2,247,267	2,129,956	4,377,223
Tuna, Yellowfin	8,847,221	15,011,271	23,858,492
Whitefish	1,026	1,725	2,751
Yellowtail	215,795	1,805,525	2,021,320
Miscellaneous Fish	70	431	501
Crustacean:			
Shrimp	9,506		9,506
Reptile:			
Turtle		546	546
Total pounds	15,313,637	19,789,748	35,103,385

* These importations are included in tables of landings. They include fish caught by California boats in foreign waters as well as frozen fish imported for canning in California plants.

CALIFORNIA FRESH FISH LANDINGS* FOR APRIL, MAY AND JUNE, 1936

Compiled by the Division of Fish and Game, Bureau of Commercial Fisheries

Species	Region 10, Del Norte	Region 20, Eureka	Region 30, Sacramento	Region 40, San Francisco	Region 50, Monterey	Region 60, Santa Barbara	Region 70, Los Angeles	Region 80, San Diego	Total pounds
Anchovy				42,600	7,160		21,959		71,719
Barracuda						4,176	1,295,828	183,957	1,483,961
Cabezone				2,549	3,570				6,119
Cabrilla							48,366	62,042	110,408
Carp			32,809					142	32,951
Catfish			38,211		445				38,656
Corbina, Mexican							15,112	17	15,129
Cultus, Pacific	2,278	58,268		100,699	42,587	81	7	2,220	206,140
Eel				25					25
Flounder, Starry		71	150	103,130	969				104,320
Flying Fish							26,222		26,222
Grouper							8,723	12,337	21,060
Hake				7,060			1,530		8,590
Halibut, California				2,588	4,681	51,064	173,675	142,848	374,856
Halibut, Northern	1,411	396,779		38,582					436,772
Hardhead			35,375						35,375
Herring, Pacific					140			6	146
Kingfish				8,899	53,800	26	105,931	115	168,771
Mackerel, Horse					5,455		462,023	59,826	527,304
Mackerel, Pacific					98,979	181	12,031,201	2,760,520	14,890,881
Mullet							1,264	3,529	4,793
Perch	314	775		21,299	23,966	1,699	17,970		66,023
Pike			265						265
Pompano, California					203		1,306		1,509
Rock Bass						4,107	72,981	39,231	116,319
Rockfish	6,255	54,203		195,035	825,373	104,408	76,752	75,547	1,337,663
Sablefish	178	273,733		53,730	36,804	19	63,000	210	427,674
Salmon	10,115	717,792	359,943	161,559	100,015				1,349,424
Sand Dab			250	181,501	9,357		1,903		193,011
Sardine				898,300	338,525		21,585	323,684	1,582,094
Sculpin						107	35,532	1,352	37,081
Sea-bass, Black					25	286	81,005	26,357	107,673
Sea-bass, Short-fin								105	105
Sea-bass, Totuava							122,138		122,138
Sea-bass, White					179	13,632	312,517	33,952	360,280
Shad			2,087,880	21,842					2,109,722
Shark				5,945		6,041	90,948	11,649	114,583
Sheepshead							9,747	1,193	10,940
Skate				60,825	3,901	5,235	4,723	2,674	77,358

6—35375

Smelt		1,664		100,122	33,910	11,353	59,743	4,061	210,853
Sole	23	136		2,066,409	19,054	117,433	3,587	21	2,236,662
Split-tail			10,408						10,408
Sucker			17,964						17,964
Swordfish, Broadbill							69,366	6,356	75,722
Tomcod				55					55
Tuna, Albacore							292,554	67	292,621
Tuna, Bluefin							9,764,611	277,585	10,042,196
Tuna, Bonito							414,496	193,886	608,382
Tuna, Skipjack							2,247,267	2,129,956	4,377,223
Tuna, Yellowfin							8,847,221	15,011,271	23,858,402
Turbot				20,322	2,771		3		23,096
Whitebait	21,759	82,069		5,750	6,208				115,786
Whitefish						60	4,377	1,725	6,162
Yellowtail							364,436	1,814,190	2,178,626
Miscellaneous Fish		857	80	47,851	90	591	315	661	50,445
Crustacean:									
Crab	15,922	77,688		361,708	144				455,462
Crab, Rock						76	5,542		5,618
Prawn					240				240
Shrimp				443,558			9,506		453,064
Mollusk:									
Abalone				29,817	650,550	525,388	275		1,206,030
Clam, Cockle		51		399			5,155		5,608
Clam, Gaper		144		1,002					1,146
Clam, Pismo					1,176	45,565			46,741
Clam, Soft-shell				30,224					30,224
Clam, Washington		3,635		869					4,504
Mussel					300				300
Octopus		140		7,307	14,850		47		22,344
Oyster, Eastern				54,565					54,565
Oyster, Japanese				43,587	4,725				48,312
Oyster, Native				13,552					13,552
Squid					725,666		2,977		728,643
Reptile:									
Turtle								546	546
Total pounds	58,255	1,068,008	2,583,335	5,133,265	3,015,818	801,707	37,196,326	23,182,038	73,759,652

* Importations of fresh fish from foreign countries included. See foreign importation tables.

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CALIFORNIA FISH AND GAME

Author and Subject Indexes

Volumes 1-20, Inclusive, 1914-1934

Compiled by
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EXPLANATORY NOTE

In the author and subject indexes, the titles are listed chronologically and then alphabetically when more than one article by the same author appeared in one year. Unsigned notes and articles are listed under "Anonymous." However, many brief notes of only current interest were omitted. The volume number is in bold-face type, followed by the pagination and illustrations, if any. For the purpose of simplification and to make the subject index useful to all readers, common names are used in preference to scientific nomenclature.

September 5, 1935.

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Bryant, Harold C.
1921. Publications of the California Fish and Game Commission, 1870–1920. 7:87–98.
1924. Scientific investigation by the California Fish and Game Commission. 10:51–62, 2 figs.

CALIFORNIA. STATE FISH EXCHANGE

Warner, O. L.
1933. State Fish Exchange merges with Division. 19:270.

CALIFORNIA DEVELOPMENT ASSOCIATION

Dunwoody, Charles.
1927. The viewpoint of an onlooker. 13:110–112.

CALIFORNIA STATE FISHERIES LABORATORY

Bryant, Harold C.
1924. Scientific investigation by the California Fish and Game Commission. 10:51–62, 2 figs.
Scofield, W. L.
1928. How a natural resource is being administered. 14:21–25, 1 fig.
Thompson, William F.
1920. The fisheries laboratory and its work. 6:177–178.
1921. The new California State Fisheries Laboratory. 7:150–153, 2 figs.

CALIFORNIA STATE FISHERIES LABORATORY LIBRARY

Anonymous.
1928. Library of California State Fisheries Laboratory. 14:317–318.
Thompson, William F.
1924. The library of the State Fisheries Laboratory. 10:91.

CANALS, IRRIGATION

Phillips, Julius B.
1931. Netting operations on an irrigation canal. 17:45–52, 7 figs.

CARP

Walford, Lionel A.
1930. Tai and carp. 16:234–237, 4 figs.

CATFISHES

Neale, George.
1915. The catfish in California. 1:62–64.

CATS

Fry, Walter.
1926. The California ring-tailed cat. 12:77–78.

CATTLE

Hagen, Roy M.
1922. The cattleman's rights. 8:177–179.

CHACHALACA

Classen, John W.
1927. Domesticated Mexican chachalaca. 13:295–296.

CLAMS

Anonymous.
1916. Soft-shelled clams planted in Morro Bay. 2:40.
1931. Permanent quarantine on clams and mussels. 17:446-447.
Bonnot, Paul.
1932. Soft shell clam beds in the vicinity of San Francisco Bay. 18:64–66.
Fisher, John P.
1916. Clams in San Francisco Bay. 2:209–210.
Heath, Harold.
1916. California clams. 2:175–178, 2 figs.

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FISHES—INTRODUCTION IN CALIFORNIA—Continued.

Shebley, W. H.
1917. History of the introduction of food and game fishes into the waters of California. 3:3–12, 2 figs.
1927. History of fish planting in California. 13:163–174, 4 figs.
Vogelsang, Charles A.
1931. Early history of introduction and distribution of spiny-rayed fishes in California waters. 17:238–240.

FISHES—INTRODUCTION IN MEXICO

Neale, George.
1922. Black bass shipment to Mexico. 8:114–117, 2 figs.

FISHES—INTRODUCTION IN NEW ZEALAND

Hunter, J. S.
1915. Introduced game in New Zealand. 1:41–44.
Scofield, Norman B.
1918. The quinnat salmon in New Zealand. 4:16–17.

FISHES—MARKING

Clark, G. Houghton.
1934. Tagging of striped bass. 20:14–19, 3 tables.
Scofield, W. L.
1920. King salmon marking experiment at Klamath River, 1919. 6:101–104.
1921. Sacramento River salmon marking, 1920. 7:125–126.

FISHES—MEXICO

Clark, Frances N.
1932. Introduction of Mexican fishes into southern California waters. 18:61–62.
Croker, Richard S.
1932. The white sea-bass and related species that are sold in California fish markets. 18:318–327, 8 figs.
Walford, Lionel A.
1930. Mexican fish in San Pedro markets. 16:189.

FISHES—NEW ZEALAND

Hunter, J. S.
1915. Introduced game in New Zealand. 1:41–44, 2 figs.

FISHES—PARASITES

Bonnot, Paul.
1933. Parasites of fishes. 19:9–15, 2 figs.
Van Roekel, H.
1929. Acetic acid as a control agent for cyclochaete and gyrodactylus in hatchery trout. 15:230–234, 2 figs.

FISHES—PRESERVATION AND PREPARATION

Bauder, C. S.
1920. Kamaboko being manufactured at San Pedro. 6:82.
Beard, Harry R.
1921. California sardine food products and their preparation. 7:238–247, 6 figs.
1921. A selected bibliography of chemical literature pertaining to the fish industry. 7:256–260.
Fry, Donald H., Jr.
1932. Cooking and cleaning losses in canning tuna. 18:165–168.
Hendrickson, Norman.
1921. Inspection in the southern California fish canneries. 7:248–249.
Scofield, W. L.
1925. Mild curing salmon in California. 11:62–68.

FISHES—SALTON SEA

Thompson, William F.
1920. Investigation of the Salton Sea. 6:83–84.
Thompson, William F., and Bryant, Harold C.
1920. The mullet fisheries of Salton Sea. 6:60–63, 3 figs.

FISHING METHODS AND GEAR—Continued.

Bonnot, Paul.
1930. The California whitebait fishery. 16:130–136, 5 figs.
1930. Report on the relative merits and demerits of purse seines vs. lampara nets in the taking of sardines. 16:125–130, 2 figs.

Chute, George Roger.
1929. The crab fishery of Monterey Bay, California. Catching the *Cancer magister* with nets. 15:28–33, 3 figs.
1929. The Spanish *cerco real* or "royal blockade net." An ancient sardine gear. 15:118–124.

Clark, G. Houghton.
1932. Relative destructiveness of sardine circle nets in southern California. 18:219–222.

Craig, Joseph A.
1927. Effect of the recent law prohibiting the taking of barracuda in California waters with purse seine or round haul nets. 13:18–25, 5 figs.

Fry, Donald H., Jr.
1933. Operation of a California shrimp trawl. 19:264–267, 4 figs.

Godsil, Harry C.
1931. The relative efficiency of the semipurse seine compared with the round haul net. 17:52–53.

Higgins, Elmer, and Holmes, Harlan B.
1921. Methods of sardine fishing in southern California. 7:219–237, 16 figs.

Lindner, Milton J.
1930. Luminescent fishing. 16:237–240, 2 figs.

Maddox, Coburn F.
1927. Bagging broadbills in California waters. 13:259–261, 1 fig.
1930. A shocking fish tale. Electrocuted tuna easily landed. 16:136–139, 3 figs.

Nidever, H. B.
1926. Purse seining in southern California. 12:45.

Phillips, Julius B.
1930. Change in fishing for Monterey sardines. 16:269–270.
1931. Live boxes for abalones at Monterey. 17:85.
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1932. Circle gill netting for smelt. 18:149–155, 6 figs.
1932. Improvements in sardine fishing gear in the Monterey region (1930–1932). 18:328–331, 3 figs.
1932. A survey of the destructiveness of sardine nets used in the Monterey region. 18:208–218, 5 figs.
1934. Changes in sardine fishing gear in the Monterey region, with a note on expansion of fishing grounds. 20:134–139, 3 figs.

Rankin, Edward P.
1915. The halibut fishery of the Pacific coast. 1:117–119.

Roberts, Ruth Kellett.
1932. Conservation as formerly practiced by the Indians in the Klamath River region. 18:283–290, 3 figs.

Scofield, Norman B.
1924. The lampara net. 10:66–70.
1924. The purse seine. 10:182–186, 3 figs.
1928. Why California sardines are caught at night rather than by day. 14:250.

Scofield, W. L.
1921. Gear used for salmon trolling in California in 1920. 7:22–38, 7 figs.
1924. Squid at Monterey. 10:176–182, 4 figs.
1926. Purse seines for California sardines. 12:16–19.

Snyder, John O.
1924. Indian methods of fishing on Trinity River and some notes on the king salmon of that stream. 10:163–172, 6 figs.

Thompson, William F., and Higgins, Elmer.
1923. Review of Dr. Skogsberg's report on the purse seine fisheries of California. 9:87–98, 3 figs.

FISHING PORTS

Corwin, Genevieve.
1929. Comparison of English and United States fishing ports, 1926–1927. 15:321. (Correction, 16:191.)

Croker, Richard S.
1930. The smaller fishing ports of central California. 16:324–329, 4 figs.

POLLUTION—Continued.

Weymouth, Frank W.
1919. A case of destruction of Pismo clams by oil. 5:174–175, 1 fig.

POMPANO

Starks, Edwin Chapin.
1918. The mackerel and mackerel-like fishes of California. 4:118–129, 12 figs.

PORCUPINES

Keyes, Joseph.
1934. Porcupine control on forests of California. 20:148–150, 2 figs.

PORTS, FISHING. *See* Fishing Ports.

PRAWNS

Phillips, Julius B.
1931. Prawn fishery started at Monterey. 17:159–162. 2 figs.

PREDATORY ANIMALS. *See also* names of special animals, *e.g.*, Coyotes, Lions.

Anonymous.
1918. The dangers of the bounty system. 4:189–190.
1926. Destruction of predatory birds. 12:137–139.
Hall, E. Raymond.
1931. The coyote and his control. 17:283–290, 2 figs.
Hunter, J. S.
1921. The control of the mountain lion in California. 7:99–101, 1 fig.
Jacobsen, W. C.
1931. Ground squirrel control in California. 17:241–246.
Jotter. E. V.
1919. The coyote as a deer killer. 5:26–29, 1 fig.
McLean, D. D.
1934. Predatory animal studies. 20:30–36.
Poole, Charles G.
1933. Some facts about predatory animal control. 19:1–9, 2 figs.
Sumner, E. L., Jr.
1931. Some notes on the birds and animals of the Los Banos duck refuge with special reference to predatory species. 17:270–280, 11 figs.

PURSE SEINES. *See* Fishing Methods and Gear.

Q

QUAIL

Bade, August.
1927. Believe it or not. 13:27–28.
1930. Feeding young pheasants and quail. 16:227–230.
Bryant, Harold C.
1925. Quail poisoning experiments. 11:149–154, 1 fig.
Burghduff, A. E.
1934. Division imports quail from Mexico. 20:166–167.
Neale, George.
1915. The California valley quail and introduced game birds. 1:153–155.
Pierce, C. C., and Clegg, M. T.
1916. The effect of strychnine sulphate on California valley quail. 2:11–13.
True, Gordon H., Jr.
1933. More about the quail refuges. 19:248–252, 3 figs.
1933. The quail replenishment program. 19:20–24, 2 figs.
1934. An experiment in quail importation. 20:365–370, 2 figs.
1934. Quail banding returns for 1932 and 1933. 20:371–374, 2 figs.
U. S. Bureau of Biological Survey.
1919. Importation of quail from Mexico. 5:88–89.
Welch, Walter R.
1928. Quail shooting in California today and fifty years ago. 14:122–128, 1 fig.
1931. The propagation of California quail in open breeding grounds. 17:421–425, 3 figs.
1932. The California quail sanctuary and game refuge campaign. 18:24–29. 1 fig.

SARDINE FISHERIES—Continued.

Phillips, Julius B.
1930. Change in fishing for Monterey sardines. 16:269–270.
1932. Improvements in sardine fishing gear in the Monterey region (1930-1932). 18:328–331, 3 figs.
1932. A survey of the destructiveness of sardine nets used in the Monterey region. 18:208–218, 5 figs.
1934. Changes in sardine fishing gear in the Monterey region, with a note on expansion of fishing grounds. 20:134–139, 3 figs.

Scofield, Norman B.
1928. Sardine scarcity at Monterey. 14:83–84.
1928. Why California sardines are caught at night rather than by day. 14:250.
1934. Notes on the sardine fishery. 20:158–162.

Scofield, W. L.
1926. Purse seines for California sardines. 12:16–19.
1928. Sardine seasons at Monterey and Los Angeles Harbor. 14:198–200, 2 figs.
1934. The catch of sardines in California. 20:300–303, 5 tables.

Thompson, William F.
1921. The future of the sardine. 7:38–41, 1 fig.
1921. Historical review of California sardine industry. 7:195–206, 7 figs.
1921. Quarter-oils or half-pound ovals. 7:106–110.

SARDINE FISHERIES—PREDICTIONS

California State Fisheries Laboratory
1934. The 1934–1935 sardine season. 20:298–300.

Scofield, Norman B.
1934. Notes on the sardine fishery. 20:158–162.

SARDINES

Anonymous.
1920. The inauguration of scientific work on the sardine. 6:32.

Lindner, Milton J.
1929. Albino sardine. 15:176.

Starks, Edwin Chapin.
1918. The herrings and herring-like fishes of California. 4:58–65, 9 figs.

Thompson, Ruth Miller.
1927. California sardine investigations. Being a review of Fish Bulletin 11, "The California Sardine." 13:143–145.

Thompson, William F.
1920. The proposed investigation of the sardine. 6:10–12.
1921. The sardine of California. 7:193–194, 2 figs.

SARDINES—ABUNDANCE

Clark, Frances N.
1933. Changing abundance of the California sardine, measured by length of scouting time. 19:136–141, 6 figs.

Higgins, Elmer.
1923. Sardines abundant now—but what of the future? 9:50–51.

Scofield, Norman B.
1928. Sardine scarcity at Monterey. 14:83–84.

Scofield, W. L.
1930. Scarcity of small sardines. 16:75.

Thompson, William F.
1921. The future of the sardine. 7:38–41, 1 fig.
1921. Whales and sardines. 7:110–111.

SARDINES—EGGS AND LARVAE

Anonymous.
1929. First discovery of sardine eggs. 15:248–249.

Scofield, Eugene C., and Lindner, Milton J.
1930. Preliminary report of the early life history of the California sardine. (A contribution from the Hydrobiological Survey). 16:120–124, 4 figs.

SARDINES—GEOGRAPHIC DISTRIBUTION

Thompson, William F.
1921. The sardine of California. 7:193–194, 2 figs.

SHARKS—Continued.

Edwards, Helen M.
1920. The growth of the swell shark within the egg case. 6:153–157, 4 figs.
MacGinitie, G. E.
1931. Basking sharks on the Pacific coast. 17:445–446.
Starks, Edwin Chapin.
1917. The sharks of California. 3:145–153, 13 figs.
Thompson, William F.
1921. The basking shark at Monterey. 7:178.
Walford, Lionel A.
1933. Commercial uses of sharks and rays. 19:179–188, 7 figs.

SHEEP

Gardner, Leon L.
1918. Bighorn sheep in the vicinity of Claremont, California. 4:17–21, 1 fig.
Miller, Loye.
1927. The mountain sheep in the San Jacinto region. 13:67–68.
Ober, E. H.
1931. The mountain sheep of California. 17:27–39, 6 figs.

SHRIMP FISHERIES

Fry, Donald H., Jr.
1933. Operation of a California shrimp trawl. 19:264–267, 4 figs.
Scofield, Norman B.
1919. Shrimp fisheries of California. 5:1–12, 5 figs.

SKATES

Starks, Edwin Chapin.
1918. The skates and rays of California, with an account of the rat fish. 4:1–15, 18 figs.

SKUNKS

Sumner, E. L., Jr.
1932. An outline of the habits of the striped skunk and little spotted skunk with some directions for trapping. 18:34–43.

SMELTS

Clark, Frances N.
1928. The smelts of the San Pedro wholesale fish markets. 14:16–21, 4 figs., 2 tables.
1934. The life history of the bay smelt. 20:157–158.
Phillips, Julius B.
1932. Circle gill netting for smelt. 18:149–155, 6 figs.

SPORT FISHING

Bandini, Ralph.
1933. The saga of big game fishing. 19:173–178.
1933. Swordfishing. 19:241–248, 4 figs.
Boutan, C. M.
1917. Striped bass fishing. 3:53–54.
Cole, Charles E.
1930. Angling for striped bass. 16:286–293, 5 figs.
Croker, Richard S.
1931. Sport fishing in southern California. 17:339–340.
French, Dwight G.
1916. Fishing at Santa Catalina Island—its development and methods. 2:14–19, 1 fig.
Fry, Donald H., Jr.
1932. Barge fishing, a southern California sport. 18:244–249, 4 figs.
Holder, Charles Frederick.
1914. Attempts to protect the sea fisheries of southern California. 1:9–19.
Hubback, C. E.
1927. Striped bass as I know them. 13:25–27.
Kauffman, Earl R.
1930. Black bass fishing tackle—using the right tackle is more than half of angling pleasure. 16:293–296.
1931. Trouting. 17:146–150.

STREAMS—Continued.

Needham, Paul R.
1934. Notes on stream survey work in California. 20:295–296.

STRIPED BASS

Anonymous.
1919. Striped bass taken in Mission Bay, San Diego County, California. 5:197.
1922. Striped bass decreasing. 8:238.
1929. Striped bass to be planted in Salton Sea. 15:254–255.
1930. Salton Sea bass. 16:338.
1930. Striped bass introduced in Salton Sea. 16:51.
1932. Striped bass in Newport Bay. 18:57–58, 1 fig.
Boutan, C. M.
1917. Striped bass fishing. 3:53–54.
Clark, G. Houghton.
1932. The striped bass supply, past and present. 18:297–298, 1 fig.
1934. Tagging of striped bass. 20:14–19, 3 tables.
Cole, Charles E.
1930. Angling for striped bass. 16:286–293, 5 figs.
Hubback, C. E.
1927. Striped bass as I know them. 13:25–27.
Scofield, Norman B., and Bryant, Harold C.
1926. The striped bass in California. 12:55–74, 5 figs.
Walford, Lionel A.
1932. Big-eyed bass and striped bass. 18:262–263, 2 figs.

STRIPED BASS—AGE DETERMINATION

Scofield, Eugene C.
1932. A simple method of age determination of striped bass. 18:168–170, 1 fig.

STRIPED BASS—LIFE HISTORY

Scofield, Eugene C.
1928. Striped bass studies. 14:29–37, 4 figs.
Scofield, Norman B., and Bryant, Harold C.
1926. The striped bass in California. 12:55–74, 5 figs.

STRIPED BASS FISHERIES

Craig, Joseph A.
1928. The striped bass supply of California. 14:265–272, 3 figs.
Scofield, Norman B., and Bryant, Harold C.
1926. The striped bass in California. 12:55–74, 5 figs.

STURGEON

Green, W. J.
1926. Sturgeon on increase. 12:108–109.

SUNFISHES

Neale, George.
1931. The spiny-rayed game fishes of the California inland waters. 17:1–17, 11 pls. (6 col.), 9 figs.
Scofield, Norman B.
1916. Calico bass, sharp-eared bass, and bluegill sunfish. 2:210.
Vogelsang, Charles A.
1931. Early history of introduction and distribution of spiny-rayed fishes in California waters. 17:238–240.

SWORDFISHES

Bandini, Ralph.
1933. Swordfishing. 19:241–248, 4 figs.
Maddox, Coburn F.
1927. Bagging broadbills in California waters. 13:259–261, 1 fig.
Starks, Edwin Chapin.
1918. The mackerel and mackerel-like fishes of California. 4:118–129, 12 figs.

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YELLOWTAIL

Starks, Edwin Chapin.
1918. The mackerel and mackerel-like fishes of California. 4:118–129, 12 figs.
Whitehead, Seward S.
1933. Condition of the yellowtail fisheries. 19:199–203, 2 figs.

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1933—ABSTRACT CALIFORNIA SPORTING FISH & GAME LAWS—1935

THIS ABSTRACT WILL BE VALID UNTIL 90 DAYS AFTER ADJOURNMENT OF THE 1935 LEGISLATIVE SESSION

OPEN AND CLOSED SEASONS

WHITE SQUARES INDICATE OPEN SEASON. NUMBERS IN SQUARES ARE OPEN DATES

GAME	DISTRICTS	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	BAG AND POSSESSION LIMITS, ETC.
DEER	1½										15			No Does, Fawns or Spike Bucks. No Forked Horned Deer in Dist. 1½. No sale of Venison or Deer Skins. Two Bucks per Season except in 1½ where limit is one. See Notes 6-9-10-12
DEER	2-2½-3									14				
DEER	2½-4-4½								16	15				
DEER	1-1½-4½-23-20									16	15			
Rabbits—Cottontail and Brush	ALL EXCEPT 4, 4½, 19, 21											15	15	15 per day. 30 per week. Season always open in 4, 4½, 19, 21
Bear, Fur Animals	ALL											16		See Note 7
Ducks, Geese, Jack Snipe, Mud Hens	ALL — FEDERAL LAW	See Note →												Federal regulations will be enforced in California and will be published as soon as announced by Federal authorities.
Ducks, Geese, Jack Snipe, Mud Hens	ALL — STATE LAW	15												[illegible] See notes 9 to 11 [illegible]
Quail—Valley, Desert and Mountain	ALL EXCEPT 1½											15		Valley - Desert - Mountain. Each Variety. 10 per day. 10 in possession. 20 per week
Quail—Valley, Desert and Mountain	1½													
Dove	ALL EXCEPT 4-4½-4¾													15 Per Day. 15 in possession. 30 Per Week
Dove	4-4½-4¾													
Pheasant												15 30		2 Male birds per day. 2 in possession
Pigeon													15	10 per day. 10 in possession. 20 per week

There is no open season on Elk, Antelope, Mountain Sheep, Sea Otter, Beaver, Tree Squirrel, Sierra Hare, Rail, Wood Duck, Swan, Shore Birds (except Jack Snipe), Grouse, Sage Hen, Imported Quail, Partridge, or Wild Turkey

FISH	DISTRICTS	JAN.	FEB.	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	BAG AND POSSESSION LIMITS, ETC.	
Steelhead and all Trout (except Golden) Whitefish. Unlawful to take trout in waters closed by Governor's proclamation	[illegible] Klamath River, Lake Almanor													Bag limit for taking and possession, 25 trout or 10 pounds and one trout.	No Sale. No Spearing. For other restrictions See Notes 12-15-16-20-21-22-27-28-30-32 On this Card
	2½		25			30									
	23-25					10									
	Truckee River					15									
	See Note 22														
	1½-5 and Waters Klamath River		25											5 Trout regardless of weight	
	[illegible]		26											3 Trout regardless of weight	
	Sacramento River between [illegible] Ferry and Middle Creek, Shasta County													3 Trout regardless of weight	
Golden Trout	ALL EXCEPT 1-4½													20 per day. None under 5 inches. Not more than 10 lbs. and one. See Note 22	
	1-4½, [illegible]														
BLACK BASS	ALL EXCEPT 4½					29								15 per day [illegible]	No Black Bass under 9 in. No sale. Hook and line only
	CLEAR LAKE													Clear Lake 10 per day	
Sunfish	ALL					29								25 per day	
Sacramento Perch and Crappie	ALL EXCEPT CLEAR LAKE					29								25 per day	Hook and line only. No sale
	CLEAR LAKE													10 per day	
Striped Bass	ALL													[illegible] None under 12 inches, 5 per day [illegible] See Notes 18 and 24	
Crabs	ALL EXCEPT 1½-6-7-8-9							10				15		Season Districts [illegible] December 15 to August 30. See Note 21. None under 7 inches. No Female	
Abalones		15		16										Only for food. Must be brought to shore alive in shell. Angling License Required. See Note 26	
Pismo Clams	17													None under 5 inches. No shipment. 15 per day. Angling License Required. District 16 a Closed	
Spiny Lobster	ALL													No Sale of Meat. None under 10½ or over 16 inches. See Note 23	
GRUNION	ALL														

SALMON, See Note A. STURGEON, No Open Season (possession prohibited).

NOTES

IT IS ALWAYS UNLAWFUL

1. To hunt, kill, possess wild birds or mammals, to possess firearms, except under written permit from the Commission, in Dists. 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j, 1k, 1m, 1n, 1o, 1p, 1q, 1r, 1s, 1t, 2a, 2b, 3a, 2b, 3c, 3d, 3e, 3f, 3g, 3h, 4a, 4b, 4c, 4d, 4e, 4f, 4g, or General Grant Refuge, or Mt. Tamalpais Game Refuge, including Richardson Bay, or San Francisco Refuge, or Silver Lake Refuge (water fowl may be killed in 4a and 4e), or to hunt quail in Bolinas Quail Refuge, or to hunt or discharge firearms in Huntington Lake Refuge, San Leandro Bay Refuge, or Monterey Peninsula Refuge.

2. To hunt birds or mammals excepting predators without a hunting license. To hunt in areas closed by proclamation.

3. To possess any bird net or to net, trap or to hold protected game or birds of any kind, their nests or eggs except under written permit from the Commission.

4. To take more than 4 geese per day, 8 per week of all varieties, and 12 Canada geese and black sea brant. To take more than 25 mud hens per day, 50 per week. To have more than 1 daily bag limit of geese and mud hens in possession by 1 person in 1 day.

5. To take or kill nongame birds, except blue jay, butcher bird, English sparrow, sharp-shinned, Cooper or duck hawk, great horned owl, linnet, crow, black-billed magpie, white pelican, shag, and in Dists. 1, 2, 3, 4 and 4½, blackbirds.

6. To hunt deer without deer tag license. To fail to attach to horns of deer immediately on killing, properly filled out deer tag or at same time to send duplicate tag to Division. To carry deer into closed district without having deer tag countersigned, or to have untagged deer in possession. To fail to retain in possession during open season and for 10 days after, skin and portion of head bearing horns of deer killed and to produce upon demand. To use more than 1 dog to hunter in hunting deer or to allow dogs to run deer in closed season, or to possess doe or fawn skins, or deer skins not bearing evidence of sex.

7. To trap for profit without first procuring a trapping license bear, ring-tailed cat, coon, pine marten, skunk, fisher, wolverine, mink, river otter, fox or muskrat, or to kill same during closed season, except when destroying property. To interfere with traps of licensed trappers. To use saw tooth or spike-jawed traps for taking fur bearers.

8. To use any animal other than dog to stalk wild birds.

9. To shoot game from power boat, sailboat, auto, airplane, or to hunt waterfowl from scull boat in Dists. 8, 9, except on Wed. and Sun., or at any time in Dist. 12 or Napa River south of Edgerly Island, and in Mare Island Straits from the Napa River to Carquinez Strait, or to use shotgun larger than 10 gauge, or to possess an extension automatic or cane gun. To have in possession any device capable of or to be used in silencing the report of any firearm.

10. To shoot resident game between ½ hour after sunset and ½ hour before sunrise, or migratory game between sunset and ½ hour before sunrise. To use a spotlight in hunting game.

11. To drive game birds by means of auto, airplane, or power boat over shooters.

12. To hold game or fish longer than 5 days after close of season; venison 15 days.

13. To sell wild game, except cottontail and brush rabbits.

14. To make a false statement in applying for license. To fail to show license upon demand to any officer.

15. To take game or fish from one district to another when season is not open in both. (Special law for deer, trout and black bass.) Trout legally taken may be transported from open district into closed district by the consignor making an affidavit in duplicate setting forth his name, address, number of angling license and name and address of consignee. Original must be attached to shipment; copy left on file with officer before whom sworn. Trout may be shipped into closed district when accompanied by written statement to effect that trout were legal, signed by shipper, countersigned by agent to whom offered for shipment. Black bass legally taken may be transported from open district into closed district.

16. To ship wild birds, mammals, or fish except smoked or dried fish other than trout by parcels post, or in concealed packages or without a tag bearing name and address of consignee and consignor and contents, or to ship game out of State.

17. To operate a commercial hunting club without license.

18. To place obstructions in streams in Dists. 1, 1½, 2, 2½, 2¾, 3, 4, 4½, 23 and 25 that will stop or impede fish.

19. To sell striped bass taken with hook and line; to transport or carry striped bass out of State. To ship striped bass less than 20 in. in length or more than 10 lbs. in weight. To possess more than 5 shad per day between June 1 and Feb. 14.

20. To take trout other than with rod and line held in hand or with lure with more than 2 attractor blades or more than 3 hooks. To take trout except by angling in such manner as to cause trout to voluntarily take hook in its mouth.

21. To have in possession any fish spear or gaff (except landing gaff) within 300 feet of any lake or stream when unlawful to spear salmon.

22. To take trout in any lake within 300 feet of mouth of any stream from Oct. 31 to Aug. 1, or in that portion of any stream flowing into any lake in Dist. 23 within 2 miles from its mouth, upstream, from Oct. 31 to Aug. 1. To take golden trout in Cottonwood Lakes group, including South Fork Cottonwood Lakes group and ½ mile of stream below the lower lake in each of said groups, except from July 1 to Oct. 31.

23. To bring to shore crabs or lobsters in such condition that size can not be taken; or to ship or carry crabs out of Dists. 1½, 2½, 5, 6, 7, 8 or 9. To sell any crabs taken in Eel River or tributaries or to possess more than 10 crabs taken there or to take any between ½ hour after sunset and ½ hour before sunrise.

24. To take or possess in Dist. 3 salt water eels of less than 12 in. or more than 15 per day.

25. To take or possess cockles less than 1½ in. in diameter, or to take or possess more than 15 (Dists. 2 and 10) Washington clams or more than 10 horse clams or more than 30 razor or jackknife clams per day, or in Dists. 18, 19, 21 more than 15 lbs. of mussels per day. To take or possess any Pismo clams in Dist. 18 between ½ hour after sunset and ½ hour before sunrise, or to possess any clam digging implement in that district. To possess any clam digging implement in any clam preserve.

26. To take red abalones less than 7 in., in greatest diameter; green, 6½; pink, 6; black, 5; to dry abalones; to dive for abalones in Dists. 7, 15, 16, 17, 19, 20 and 20a; to take more than 10 per day or 20 per week in Dists. 7, 15, 16, 17, 19, 20 and 20a. To take more than 10 per day from shore in Dists. 7, 10 and 18; to take more than 10 black abalones per day in Dists. 15, 16, 17, 18, 19, 20, 20a, 21. To possess more than 10 per day in Dist. 2.

27. To fish for game fish without having an angling license.

28. To take game fish between 1 hour after sunset and 1 hour before sunrise in Dists. 1, 1½, 1¾, 2, 2½, 2¾, 3, 4, 4½, 4¾, 23, 25. To take striped bass by hook and line between sunset and sunrise.

29. To fish with nets except in commercial districts or to injure any legal net.

30. To fish through ice for any fish or to take fish in Dist. 14.

31. To place, cause to be placed, or discharge into any waters substances deleterious to fish or plant life.

32. To fish within 250 ft. of fishway or 150 ft. of upper side of fish screen, or lower side of dam, or to take fish except salmon within ½ mile of either side of spawning station, or any lake within ½ mile of spawning station when station is in operation.

33. To kill, injure or capture Cal. sea lions in Dists. 19, 20, 20a.

34. To take invertebrates or marine plants in Hopkins Marine Refuge (Monterey Co.) or in that area between the west line of the property of the Scripps Institute and a line 1,000 feet west of low tide line (San Diego Co.)

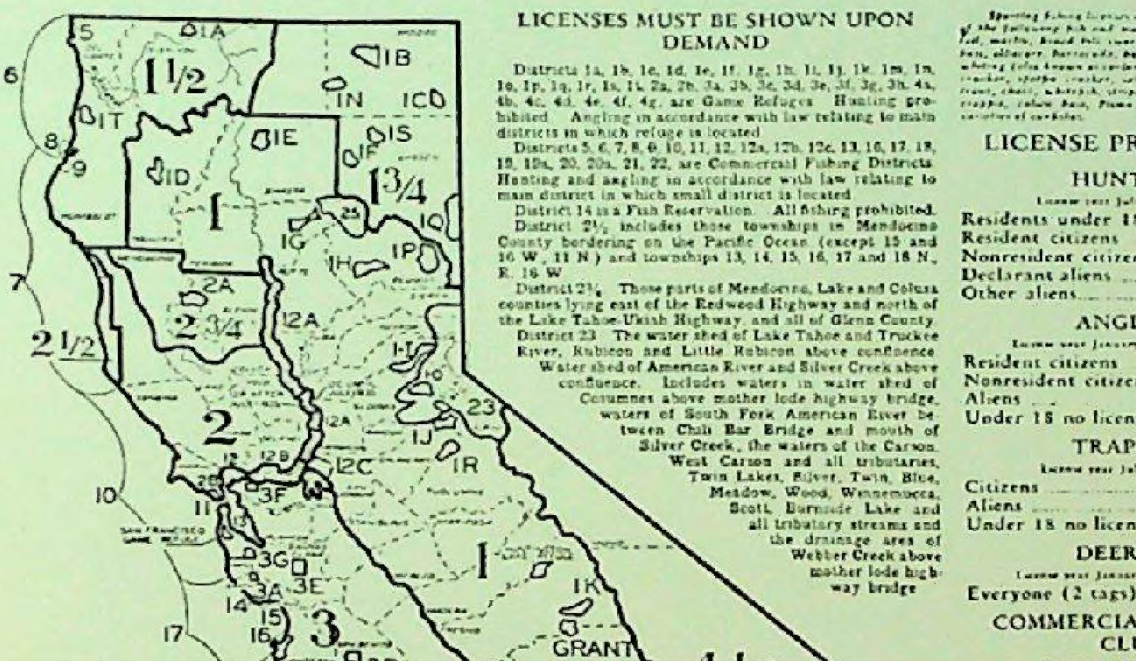
35. To take more than 5 white sea bass from May 1 to June 30, or to take at any one time more than 5 under 28 in.

36. To take more than 30 lbs. of halibut under 4 lbs. each, or to take more than 5 barracuda less than 3 lbs. each.

37. To take frogs less than 4 in. in length measured from tip of nose to posterior end of body between hind legs, or to take or possess more than 24 frogs per day or 48 frogs per week.

NOTE A.—SALMON. Salmon can not be taken on spawning beds, or within 10 miles of spawn-taking station, or 3 miles north and south of mouth of Klamath River. All salmon boats must have landing net, and no Chinook less than 27, or silver less than 24 in. can be taken in ocean and Humboldt Bay Dists. Undersized salmon can not be gaffed or clubbed, or brought ashore in such condition that size can not be determined. Salmon may be taken with hook and line in any district when trout season for said district is open.

In Dist. 1, salmon may be taken with hook and line or spear between May 29 and Oct. 31, except (a) in Feather River from its mouth to mouth of the Yuba; (b) in American River from its mouth to Fair Oaks bridge. In Dist. 2, (c) in Russian, Napa and Navarro rivers, (d) in Eel River and (e) in tidewater in Dists. 2, 3 and 15, with hook and line from May 1 to last day of Feb., bag limit 2 per day. In Feather River between mouth of Yuba and Thermalito bridge, with hook and line between May 1 and Dec. 31, bag limit 2 per day. In San Joaquin River, from mouth to Mendota weir, with hook and line from April 1 to Dec. 31. In Dist. 1¾, with hook and line from May 29 to Dec. 31; with spear from Aug. 1 to Oct. 31, bag limit 2 per day. In Dists. 2, 2½, with hook and line from May 1 to Feb. last; with spear from Nov. 1 to Feb. last, bag limit 2 per day. In Dist. 3, with hook and line from May 1 to Oct. 31, bag limit 2 per day. In Klamath River Dist. above tidewater, with hook and line from May 29 to Dec. 31; with spear, from Aug. 1 to Oct. 31, bag limit 2 per day. In Klamath River Dist. in tidewater, with hook and line from May 29 to Dec. 31. Bag limit is 3 per day from May 29 to Sept. 5, and 2 per day from Sept. 6 to Dec. 31, not more than 1 daily bag limit in possession. In Dists. 6, 7, 8, 9, with hook and line from April 1 to Sept. 15, no bag limit. In Dists. 10, 11, with hook and line from May 1 to Aug. 30, no bag limit. In Dists. 12, 12B, 12C, 13, with hook and line at any time, no bag limit. In Dist. 12A, with hook and line from May 1 to Feb. last, bag limit 2 per day. In Dists. 15, 16, 17, 18, with hook and line from Mar. 1 to July 15.



LICENSES MUST BE SHOWN UPON DEMAND

Districts 1a, 1b, 1c, 1d, 1e, 1f, 1g, 1h, 1i, 1j, 1k, 1m, 1n, 1o, 1p, 1q, 1r, 1s, 1t, 2a, 2b, 3a, 3b, 3c, 3d, 3e, 3f, 3g, 3h, 4a, 4b, 4c, 4d, 4e, 4f, 4g, are Game Refuges. Hunting prohibited. Angling in accordance with law relating to main districts in which refuge is located.

Districts 5, 6, 7, 8, 9, 10, 11, 12, 12a, 12b, 12c, 13, 16, 17, 18, 19, 19a, 20, 20a, 21, 22, are Commercial Fishing Districts. Hunting and angling in accordance with law relating to main district in which small district is located.

District 14 is a Fish Reservation. All fishing prohibited.

District 2½ includes those townships in Mendocino County bordering on the Pacific Ocean (except 15 and 16 W., 11 N.) and townships 13, 14, 15, 16, 17 and 18 N., R. 16 W.

District 2¾. Those parts of Mendocino, Lake and Colusa counties lying east of the Redwood Highway and north of the Lake Tahoe-Ukiah Highway, and all of Glenn County.

District 23. The water shed of Lake Tahoe and Truckee River, Rubicon and Little Rubicon above confluence. Water shed of American River and Silver Creek above confluence. Includes waters in water shed of Cosumnes above mother lode highway bridge, waters of South Fork American River between Chili Bar Bridge and mouth of Silver Creek, the waters of the Carson. West Carson and all tributaries, Twin Lakes, Silver, Twin, Blue, Meadow, Wood, Winnemucca, Scott, Burnside Lake and all tributary streams and the drainage area of Webber Creek above mother lode highway bridge.

Sporting fishing licenses are required for the taking of the following fish and mollusks only: Tuna, yellowtail, marlin, broadbill swordfish, jewfish or black sea bass, albacore, barracuda, bonito, rock bass, California whiting (also known as corbina and surf fish), yellowfin croaker, spotfin croaker, salmon, steelhead and other trout, shad, whitefish, striped bass, black bass, perch, crappie, calico bass, Pismo clams, abalones, and all varieties of catfish.

LICENSE PROVISIONS

HUNTING

License year July 1 to June 30

Residents under 18	$1.00
Resident citizens	2.00
Nonresident citizens	10.00
Declarant aliens	10.00
Other aliens	25.00

ANGLING

License year January 1 to December 31

Resident citizens	$2.00
Nonresident citizens	3.00
Aliens	5.00

Under 18 no license required

TRAPPING

License year July 1 to June 30

Citizens	$1.00
Aliens	2.00

Under 18 no license required

DEER TAG

License year January 1 to December 31

Everyone (2 tags)	$1.00

COMMERCIAL HUNTING CLUBS

License year July 1 to June 30

Citizens	$25.00
Aliens	100.00
Operators, citizens	5.00
Operators, aliens	25.00

For Laws in Full See Fish and Game Code

For Commercial Fish Laws See Commercial Abstract

For Information Regarding Fish or Game Write to the Division of Fish and Game

BUREAU OF PATROL

E. L. MACAULAY, Chief of Patrol — San Francisco

CENTRAL DISTRICT (Headquarters, Sacramento)

S. H. Lyons, Inspector in Charge — Sacramento
Jos. H. Sanders, Captain Northern Division — Sacramento
S. R. Gilloon, Captain Southern Division — Fresno
John O'Connell, Captain — Modesto
A. H. Willard, Captain — Nevada City
———, Sergeant — Redding

WARDENS (Northern Division)

Roy W. Anderson — Red Bluff
W. J. Black — Suisun
L. W. Dinsdale — Yuba City
C. O. Fisher — Susanville
C. L. Gourley — Weaverville
Alvin Granstrom — Downieville
Brice Hammack — Yreka
Earl Hiscox — Nevada City
A. A. Jordan — Alturas
Taylor London — Colusa
Charles Love — Redding
Leslie Mercer — Quincy
Nelson Poole — Auburn
Albert Sears — Placerville
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H. E. Black — Madera
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Ray J. Bullard — Porterville
M. S. Clark — Merced
Cliff Donham — Lemoore
Wm. Hoppe — Lodi
F. F. Johnston — Sonora
R. J. Little — Jackson
Walter I. Long — Visalia
Geo. Magladry — Modesto
J. W. Thornburg — Angels Camp
Roswell Welch — Kernville
Paul Kehrer — Fresno

COAST DISTRICT (Headquarters, San Francisco)

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Wm. J. Harp, Captain Northern Division — Ukiah
Wm. Lippincott, Captain Southern Division — San Francisco
J. D. Dondero, Captain — Eureka
Henry Lencioni, Captain — Santa Rosa
Ralph Classic, Captain — Monterey
O. P. Brownlow, Captain — Alameda

WARDENS (Northern Division)

W. C. Blewett — Crescent City
Earl Caldwell — Eureka
Ray Diamond — Willits
Scott Feland — Fortuna
J. H. Groves — Cloverdale
J. W. Harbuck — Napa
Ovid Holmes — Fort Bragg
E. J. Johnson — Lakeport
Wm. F. Kaliher — Garberville
Bert Laws — San Anselmo
Earl Macklin — Ukiah
Leo Mitchell — Point Arena
Victor Von Arx — Santa Rosa
R. J. Yates — San Rafael

(Southern Division)

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C. L. Bundock — Oakland
Ed Clements — Martinez
T. K. Duncan — Concord
Chas. England — San Rafael
E. R. Greenleaf — Monterey
Fred W. Hecker — San Luis Obispo
C. E. Holladay — San Jose
John Hurley — Martinez
Mansfield Joy — San Francisco
McPherson Lough — Palo Alto
F. J. McDermott — Santa Cruz
Tate Miller — Arroyo Grande
C. R. Peek — San Mateo
Orben Philbrick — Pacific Grove
Fred H. Post — Salinas
Lee C. Shea — San Francisco
Geo. Smalley — Richmond
Paul L. Turner — Paso Robles
J. P. Vissiere — San Juan Bautista
L. J. Weseth — Monterey

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C. S. Bauder, Inspector in Charge — Los Angeles
LaRue Chappell, Captain Western Division — Los Angeles
E. H. Ober, Captain Eastern Division — San Bernardino
L. T. Ward, Captain — Escondido
C. H. Groat, Captain — Terminal Island
——— Sergeant — Santa Barbara
——— Sergeant — Indio
——— Sergeant — Bishop

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A. R. Ainsworth	Santa Maria
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E. A. Chan	Terminal Island
A. F. Crocker	Los Angeles
Ray Ellis	Independence
Walter Engelke	Terminal Island
E. R. Hyde	Balboa
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Carmi Savage	Los Angeles
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(Eastern Division)

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Theo Jolley	Idyllwild
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R. C. O'Connor	Banning
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C. J. Walters	Independence
E. L. Walker	Independence

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Motor Vessel "Albacore," Monterey
Cruiser "Quinnat III," San Francisco
Cruiser "Yellowtail," Newport Beach
Cruiser "Broadbill," Terminal Island
Launch "Rainbow," Sacramento
Launch "Hunter," Martinez
Launch "Shrapnel," Lakeport
Launch "Silverside," Eureka

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